Sky and TELESCOPE

Eclipse camp by moonlight

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In This Issue:

Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor*
JOSEPH ASHBROOK, *Technical Editor*

Vol. XX, No. 5 — NOVEMBER, 1960

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COVER: The site of the September 5th lunar-eclipse expedition of the Tucson Astronomical and Astronautical Association to the Tucson Mountains, in Arizona. The picture was taken at 2:15 a.m. Mountain standard time, by Donald J. Strittmatter. The 13 members operated seven telescopes, ranging from two 8-inch reflectors to a 3-inch refractor. (See page 256.)

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The principal articles are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.

Frank E. Ross

ONE of the most versatile of all American astronomers was Frank E. Ross, who died September 21st at the age of 86. Today he is perhaps first remembered for the large-field lenses he developed for precise astronomical photography, and for the correcting lenses he invented to be used with great reflectors to enlarge the field of sharp definition.

Optical design was, however, only one of Dr. Ross' careers. Trained in celestial mechanics by Armin Leuschner at the University of California, in 1902 he joined the Nautical Almanac Office in Washington, D. C. There he collaborated with Simon Newcomb in a monumental study of the moon's motion. The *American Ephemeris* still bases its predicted positions of the planet Mars and of Saturn's satellite Phoebe upon orbits determined by Dr. Ross.

From 1905 to 1915 he was in charge of the International Latitude Observatory at Gaithersburg, Maryland, and then spent a decade as a physicist with Eastman Kodak Co., finally joining the staff of Yerkes Observatory in 1924. There he prepared with Mary Calvert a magnificent photographic atlas of the Milky Way, and discovered many hundreds of variables and stars with large proper motions.

For the last 30 years of his life, Dr. Ross was also connected with Mount Wilson and Palomar Observatories, and served as a consultant in the design of the 200-inch Hale telescope. At Mount Wilson he secured a famous series of photographs, through color filters, of the planet Venus; these long remained the high-water mark in the observational attack on the nature of that planet.

Precise photographic photometry was also a favorite subject of his, and led to the invention of the Ross microphotometer. He collaborated at Mount Wilson with F. H. Seares and Mary Joyner in preparing a large catalogue of accurate magnitudes of stars north of declination +80°.

In the range of astronomical fields to which he made first-rate contributions, few other American astronomers can be compared to Frank E. Ross.

J. A.

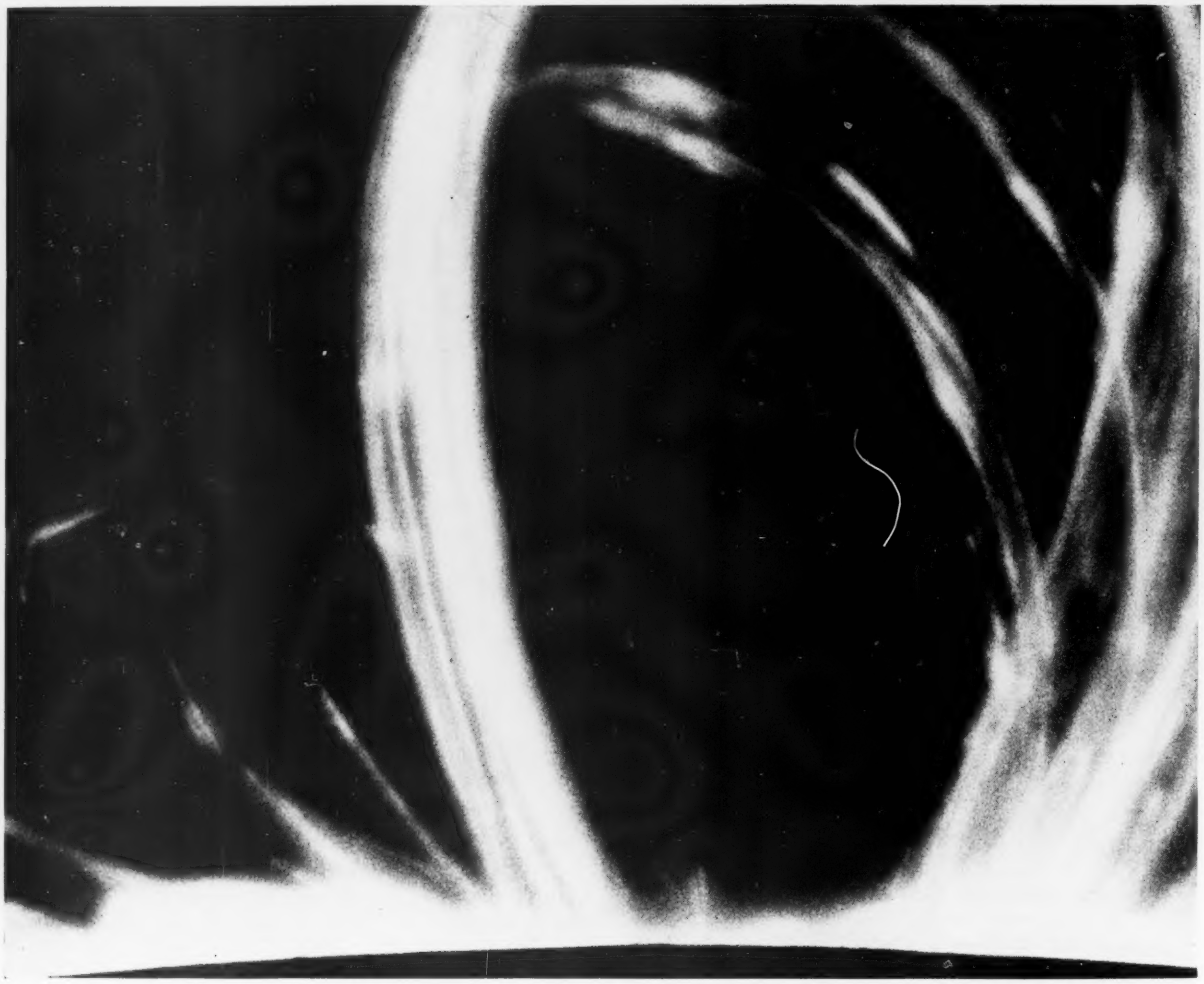


Fig. 1. These loops of glowing gas, photographed on the limb of the sun by the Sacramento Peak 15-inch prominence camera, are solar prominences of class ASl (see table on page 254). The diagram below identifies particular details for discussion. All pictures with this article are from Harvard and Sacramento Peak observatories, courtesy U. S. Air Force.

The Fine Structure of Solar Prominences—I

DONALD H. MENZEL and JOHN G. WOLBACH, *Harvard College Observatory*

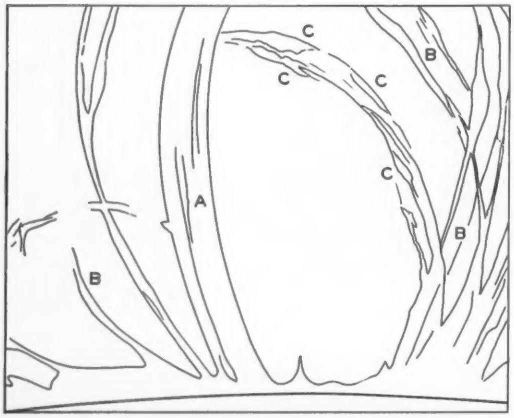


Fig. 1 (key). The loop prominence shown above and sketched here may be seen in its entirety in Fig. 2. The bright luminous structure at A is an excellent example of a filament resolved into thin parallel threads. At B, neighboring fine features brighten at contiguous places along the filaments. Some of the elongated, linked clouds that the authors liken to sausages are seen at C.

UNTIL the year 1868, astronomers could observe the red clouds of glowing hydrogen at the sun's edge – the solar prominences – only during total eclipses. Then N. Lockyer and J. Janssen independently discovered a spectroscopic technique for visual observations of these formations at any time. The modern era in the study of prominences began with B. Lyot's invention of the coronagraph (1931) and the introduction shortly afterward of optical filters with very narrow passbands.

The 6-inch coronagraph and the 15-inch prominence camera of Sacramento Peak Observatory and instruments of other solar stations have provided detailed mo-

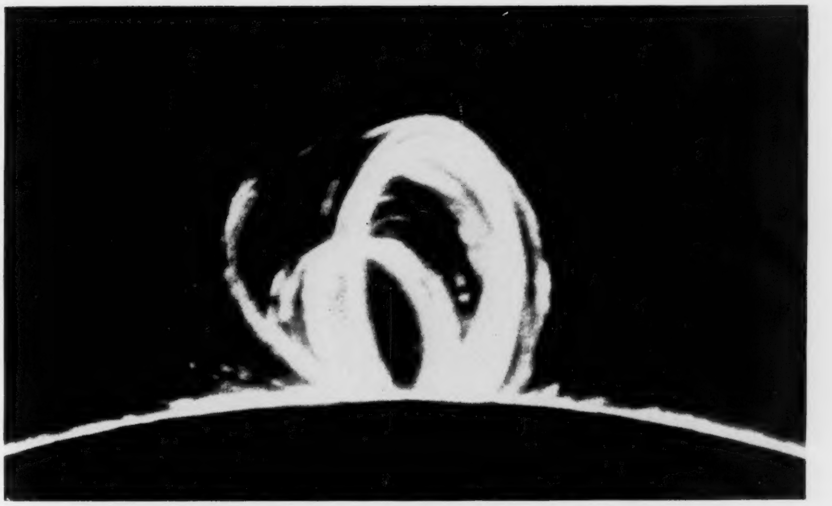


Fig. 2. In these remarkable ASI-type loops, hydrogen gas flows down each side of the nearly circular trajectory like water escaping from a piece of hose open at both ends. A number of bright knots or condensations are in the gas streams at D. The brighter filaments are partly overexposed in this 6-inch coronagraph picture taken on June 28, 1957.

tion pictures of prominence activity. These hydrogen-alpha photographs show clearly that prominences are not uniform clouds of gas, but frequently possess an intricate filamentary structure of various degrees of complexity.

The simplest form consists of one or more filaments of matter, usually moving downward from the corona. Few of these trajectories appear to be uniformly luminous; they generally display, as in Figs. 1 and 2, an irregular pattern of knots or condensations closely following one another along each filament. In size, the individual knots of gas are comparable to the earth or the moon.

As the photographs show, the knots are not necessarily round, but often elongated. These individual "dashes" sometimes lie parallel to the filament along the direction of motion and resemble a string of moving sausages. Less frequently the dashes lie perpendicular to the filament and the direction of motion (Figs. 3 and 4), and their pattern may be referred to as fishbone.

Under highest magnification, a filament occasionally is resolved into a series of fine, parallel threads with either a sausage or fishbone structure superposed. Fig. 1 shows threads of this type. Such detailed examination reveals the varying complexity of prominences, ranging from simple threads to multiple and interwoven or tangled filaments that form a vertical curtain (Fig. 5).

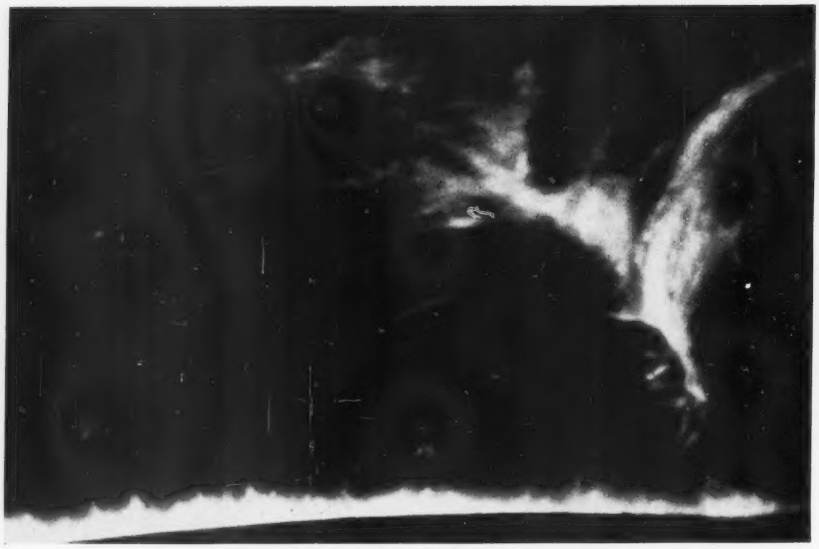
A single prominence may simultaneously exhibit sausagelike structure in one region and fishbone in another. We do not know why prominences show so wide a range of structural form, and we place no special emphasis on these details. Our desire is to emphasize how intricate the filamentary or fibrous structure can be. We also wish to show that some prominences possess diffuse or hazy filaments, while others have sharply defined fibers, with diameters less than the effective resolving power of the instrument.

To illustrate the variations of internal appearance, we have selected a variety of typical prominences from the voluminous available observational material. For each, we give the classification on a system devised by D. H. Menzel and J. W. Evans, as modified by F. Q. Orrall.

To describe both behavior and appearance of prominences, the system first divides them into two classes: *A*, in which the luminous matter comes from above, and *B*, in which it comes from below. Each class is then separated into two groups consisting of prominences associated only with sunspots, subclass *S*, and prominences not so associated, subclass *N*. The table shows the full system.

An additional behavioral description is necessary, because in the course of its de-

Fig. 3. This October 9, 1957, photograph obtained with the 15-inch prominence camera shows rain of class ASa. Several distinct flow patterns arise in various coronal sources, E. The sausagelike formations that prevail generally in this region contrast markedly with the isolated examples of nearly uniform streamers at F. Near G are a number of fine threads, both parallel and perpendicular to the general downward motion of the material. Examples of fishbone structure are at lower right.



PROMINENCE CLASSIFICATION

A (Descending)

S (Spot)	*N* (Non-spot)
a. rain	*a.* coronal rain
f. funnel	*b.* tree trunk
l. loop	*c.* tree
	d. hedgerow
	f. suspended cloud
	m. mound

B (Ascending)

S (Spot)	*N* (Non-spot)
s. surge	*s.* spicule
p. puff	

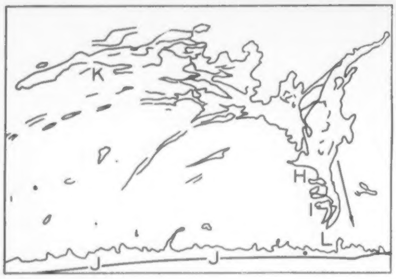


Fig. 4 (above and left). Fishbone patterns occur where matter breaks from the funnel-shaped cloud at H, and moves toward L, in the direction of the arrow. At the same time, the bright knots lengthen across this direction (I). Luminous material cascades in graceful arcs to the surface at J, while a transition from complex to simple patterns occurs at K. This ANf formation occurred July 14, 1957.

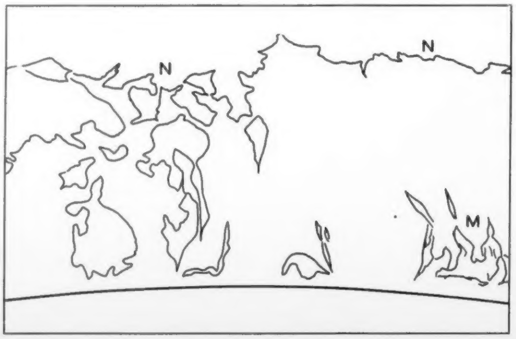
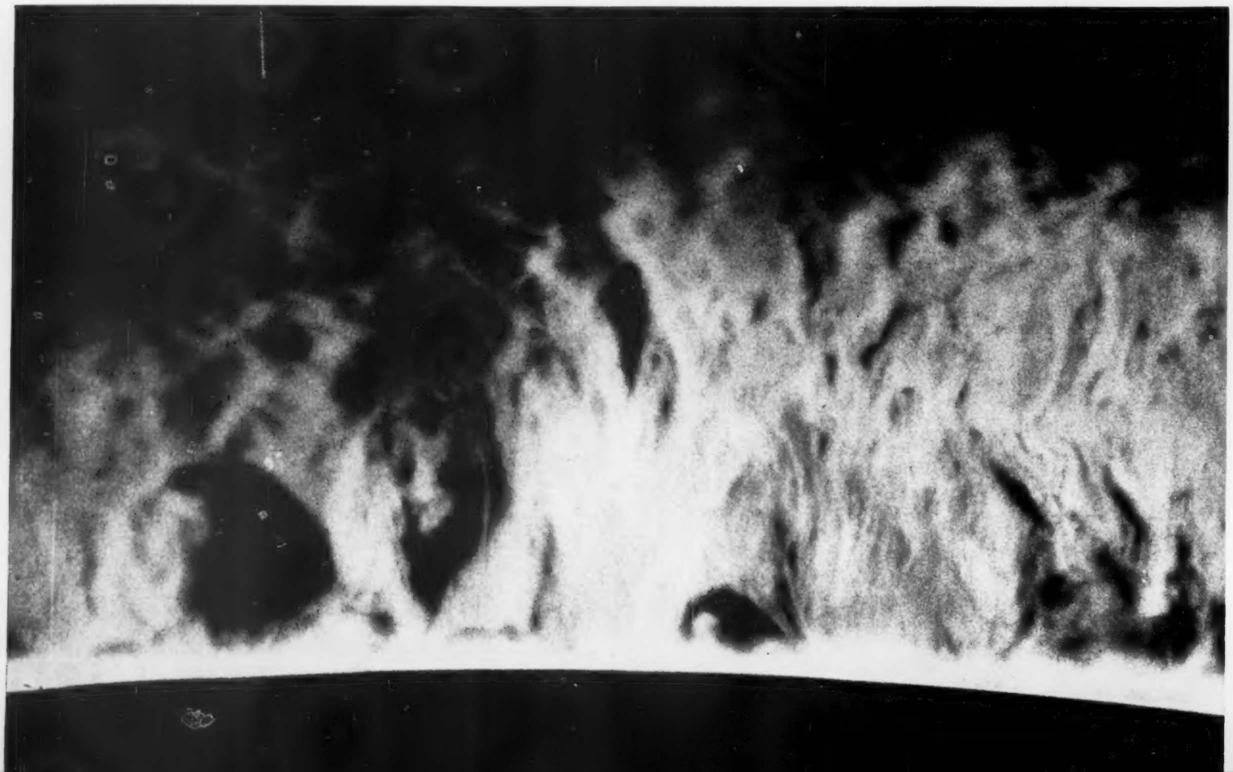


Fig. 5 (below and right). Resolution of this ANd hedgerow into filaments is evident. The dominant motion is downward, with unusual upward flow at M. Fishbone arrangement occurs at N. Three days after this prominence was photographed, it appeared as a tree, ANc, then vanished.

velopment a prominence of class *A* may suddenly ascend. At some stage of their development, many hedgerow prominences display heightened activity. The rate of downward flow increases markedly. Then the matter suddenly elevates to form an expanding arch, giving the illusion that such prominences belong to class *B* rather than *A*. Indeed, many writers term such behavior "eruptive," as distinguished from "quiescent," a category to which most class *A* prominences were once assigned. Actually the behavior of these prominences does not justify the use of either older term.

Matter continually filters through an *A* prominence, becoming luminous at the top and descending slowly with approximately uniform velocity until it flows from the bottom. The speed of descent usually ranges between 10 and 20 kilometers per second, so that the substance



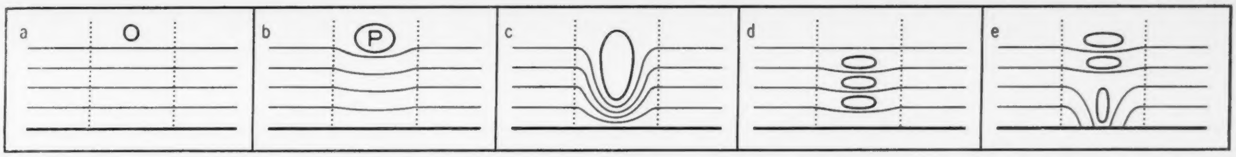


Fig. 6. A sketch to illustrate the Menzel model of a structureless prominence. The heavy horizontal lines represent the solar surface, while lighter ones indicate the magnetic field in the sun's atmosphere.

of a large hedgerow prominence some 150,000 kilometers high undergoes a complete change about once every three hours. Meanwhile, the appearance of the prominence generally remains substantially the same. As a result, we conclude that the physical conditions and the force fields responsible for the shape and distribution of the gases possess a singular degree of permanence.

With a spectroheliograph or a Lyot filter we can observe hedgerows on the face of the sun itself. In Hα light they appear as dark filaments against the bright background of the photosphere, because they absorb more light than they emit along the line of sight. Frequently, they persist for several solar rotations of approximately 27 days each.

Some years ago, one of us (Menzel) proposed a physical model for a structureless prominence, in terms of a solution of the equations of magnetohydrostatics. To understand this model and apply it to real prominences, consider the following elementary situation.

Imagine a magnetic field embedded in the hot corona, with lines of force parallel to the solar surface, as in Fig. 6a. Now suppose that, in the region indicated as **O** between the dotted lines, some disturbance causes the corona to lose energy rapidly, perhaps through radiation in the far ultraviolet. The gas cools, contracts, and subsides, carrying the magnetic lines of force with it, as shown in 6b, wherein **P** represents a prominence supported by a balance of gas pressure and magnetic forces. The prominence is supposed to extend a relatively large distance above and below the plane of the paper.

It is commonly believed that ionized gas can move only along — not across — magnetic lines of force. This statement requires some modification. The natural motion does tend to be along the field. However, motion may occur across the field, and then the lines of force are stretched and distorted as in 6c. When the displacement perpendicular to the field is excessive, in the sense that it exceeds the width of the disturbance, second-order forces come into play which may cause bubbles of ionized gas to break through the lines of force, each bubble containing some of the original magnetic field.

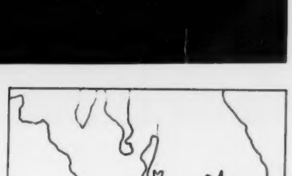
There will thus be a tendency for a column of bubbles to form, these in turn tending to elongate in the direction of the field, under the compression of both magnetic and hydrostatic forces (Fig. 6d). An alternative form is in 6e, where the lines of force are heavily stretched downward and the successive bubbles of gas are themselves compressed by the effect of the overlapping layers as the matter slowly descends along the vertical column.

The rupture of the field may occur at intervals, resulting in parallel columns of gas bubbles. Figs. 7 and 8 illustrate the rib structure formed as successive layers of matter condense and leak through the lower layers of the magnetic field. Thus, this simple model appears to account for the major features of downward-moving prominences.

(To be continued)

Fig. 7 (left). This type-ANf suspended cloud was photographed on October 9, 1959, with the 15-inch camera at Sacramento Peak. Material is flowing predominantly downward and filtering slowly from the bottom of the cloud. The arrow at Q shows the direction of motion of the material as it flows across the axis of the fishbone structure, parallel to the magnetic field.

Fig. 8 (right). The suspended cloud seen in Fig. 7 is shown about three hours later, when the seeing at Sunspot, New Mexico, had deteriorated markedly. The bubbles of luminous gas at R now flow downward, indicated by the arrow. The ribbed pattern due to multiple ruptures of the field may be noted in both pictures.



J. Russell Smith secured these pictures of the eclipse of the moon on September 5th with the 16-inch Newtonian reflector of his Skyview Observatory in Eagle Pass, Texas. The prints are contrasty, so in each case the penumbral darkening along the edge of the umbra is emphasized. From left to right, the exposure times on Tri-X film are: 1/100 second at 9:31 Universal time, 1/50 at 9:59, and 1/50 at 10:14. The first picture was taken while the moon was in the penumbral shadow, five minutes before predicted umbral contact. All times given with this article are UT.

Amateurs Photograph the Lunar Eclipse

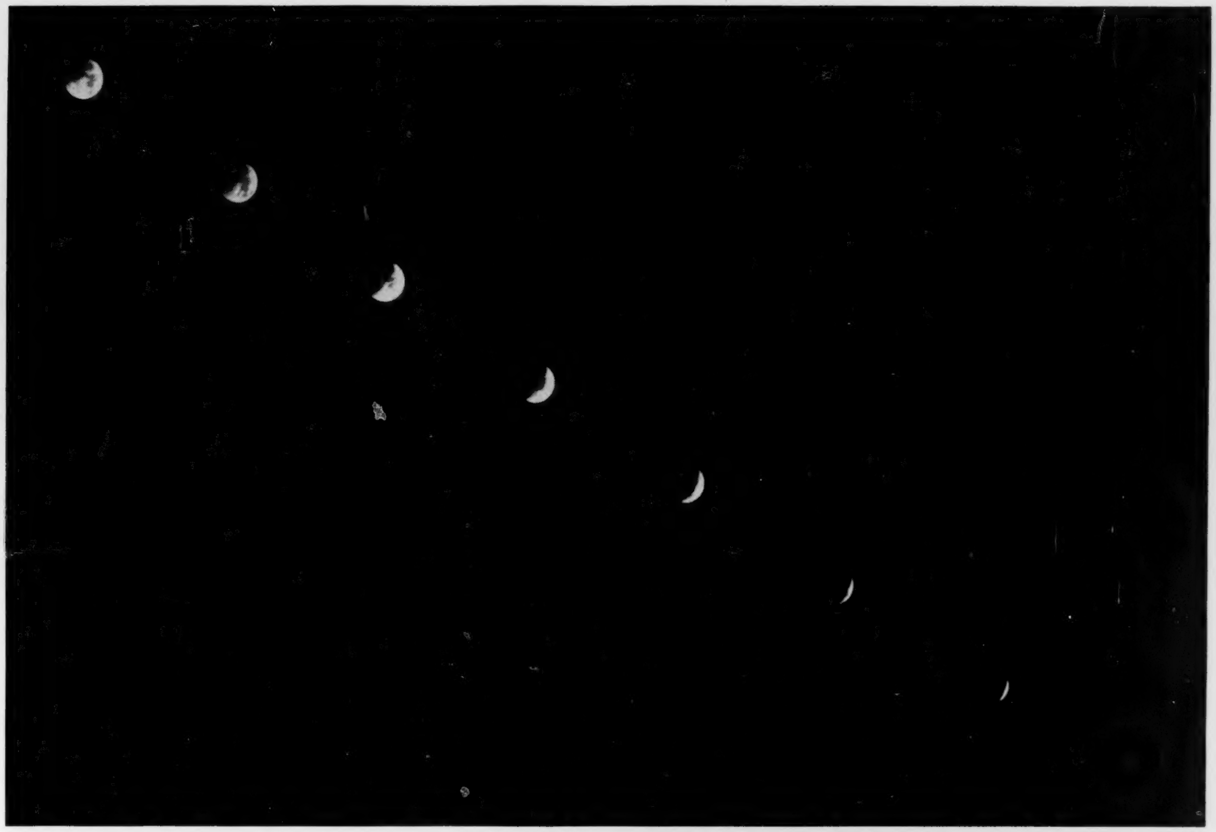
ON September 5th, generally fair weather favored most amateur observers of the total eclipse of the moon, although in the United States large areas of the East and Midwest were clouded out. Reports and pictures have been received from places as widely separated as Rhode Island, Hawaii, British Columbia, Costa Rica, and Australia. On these pages are some samples of the many excellent photographs that were taken.

Activities on eclipse night ranged from the backyard vigil of the lone amateur to large eclipse parties held by societies, and many groups made expeditions to country sites far from city lights (see front cover).

As the moon entered deep in the earth's shadow and the brightness of a full-moon night faded away, a spectacular auroral display became visible during totality for watchers in many places. One observer in British Columbia described it as "often so bright that I thought dawn was coming." This display was seen as far south as Amarillo, Texas.

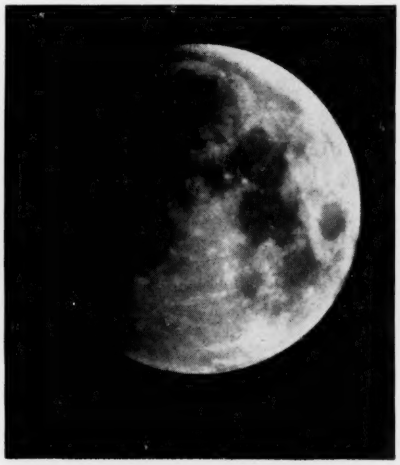
The December issue of SKY AND TELESCOPE will contain a synopsis of the visual observations of the eclipse, and a listing of the names of all persons who submitted reports or pictures of the event.

Eight-inch reflectors and eyepiece projection were used for both of these pictures. At the left, penumbral darkening is recorded at 9:28, eight minutes before umbral eclipse began. Alan L. Larson, of Burlington, Iowa, took this 1/300-second exposure on Tri-X film, through a low-power eyepiece. Below is seen the moon at 12:15, 10 minutes after totality ended. Harold J. Kendis, Jr., Los Angeles, California, used a special lens system to obtain an effective focal length of 19.5 feet, the moon's image on the negative being over two inches in diameter.

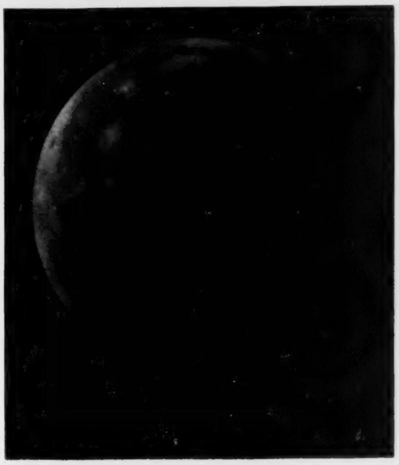


Above: Eight stages in the disappearance of the moon into the earth's shadow were recorded on a single negative by Richard Cromwell at Des Moines, Iowa. The first exposure, at upper left, was made at 9:36, at the moment of umbral contact, and shows strong penumbral darkening. Subsequent exposures were made at 10-minute intervals until two minutes before the moon was completely engulfed at totality.

Right: The series above was taken with a Mamiya C camera attached to the homemade 6-inch Springfield reflector that Mr. Cromwell is operating at the right. The telescope tube (mottled gray) is supported by a simple but sturdy pipe mounting that is firmly embedded in the ground. Tom Morehead, at the left, adjusts the eyepiece of the 10-inch portable reflector (white tube) that was used for visual observations. Mr. Cromwell took this self-photograph by pulling a black thread attached to the shutter mechanism of his camera.

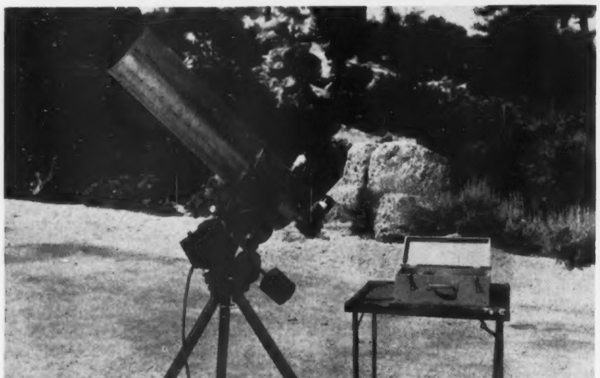


At San Carlos, California, Victor Nikolashin took pictures of the moon while it was in the penumbra, or light outer shadow of the earth, just before the umbral phase (left) and while it was emerging from the umbra (right). The 1/25-second exposures were secured at the Newtonian focus of a 6-inch f/6 homemade reflector. The first picture, at 9:36 (umbral contact), was on a 103a-O spectroscopic plate developed for four minutes in D-19 to bring out the penumbral shading. The other, at 12:45, was on Polaroid film with an ASA rating of 200, developed in D-11 for about five minutes. As with all other photographs in this article, the moon is shown uninverted, with north at the top.



Above: Thirteen members of the observing section of the Tucson Astronomical and Astronautical Association watched the eclipse at Gates Pass picnic area, 10 miles west of the Arizona city (see the front-cover photograph). This series of moon shots by group leader Donald J. Strittmatter shows the moon in the umbral shadow at 10-minute intervals, beginning at 10:06 and ending two minutes before totality. The image formed by his 8-inch reflector was projected through a 32-mm. Erfle eyepiece and recorded by a Bronica single-lens reflex camera on Royal-X Pan film. The large dark sea at the right is Mare Crisium, with Mare Tranquillitatis to its left and Mare Foecunditatis below.

Left: For one year, Eddie Ries, a 14-year-old high school sophomore from Pico Rivera, California, has taken about 250 pictures of the moon, including a record of the entire lunar cycle, for his science fair project. The eclipse photograph here was made at 12:53 on Royal Pan film, with his 6-inch reflector at 60x. Tycho is prominent at the lower left; Plato is the dark crater at the upper right.



Part of the equipment set up by Fred Larsen of Los Angeles, California, for viewing the lunar eclipse, as well as the eclipse of the sun on September 20th (see page 282). His main instrument, at the left, is an 8-inch Cassegrainian used for close-ups of the last part of the lunar eclipse. At the right, an old De Vrey camera was attached to a 5-inch achromatic telescope for color movies, taking one picture per second. The moon's image almost filled the 16-mm. frame.

The Problem of Cygnus A

OTTO STRUVE
*National Radio Astronomy Observatory**

Fig. 1. This greatly enlarged portion of a photograph taken with the 200-inch shows the peculiar object — possibly a pair of colliding galaxies — in the position of the cosmic radio source Cygnus A. The very faint halo is larger than this field. Mount Wilson and Palomar Observatories photograph.

IN 1944, Grote Reber's pioneer radio map gave a first rough view of the northern heavens in radiation of 1.9 meters wave length. This historic chart (reproduced on page 191 last month) showed a broad band of emission stretching across the sky, corresponding in position with the Milky Way. Superimposed on the band were three strong concentrations in the constellations Sagittarius, Cassiopeia, and Cygnus, that are now known as three of the most intense discrete radio sources in the sky.

The first of these, Sagittarius A, coincides with the center of our galaxy. F. D. Drake has recently resolved it into four symmetrically placed components. The inner two are clouds of hot hydrogen gas, while the outer pair probably represent a gaseous ring, whose plane coincides with the plane of symmetry of our galaxy, the ring radiating by the synchrotron process. The source Cassiopeia A, which I discussed last month, is probably the remnant of a supernova that exploded about 260 years ago.

Cygnus A remained unidentified with any optically observable feature until, nine years ago, F. G. Smith at Cambridge, England, accurately measured its coordinates as $19^h\ 57^m\ 45^s.3$, $+40°\ 35'.0$ (1950). In this same spot, W. Baade and R. Minkowski photographed a peculiar 18th-magnitude galaxy, evidently the source of the radio emission.

This faint object has an abnormal appearance, consisting of a pair of distinct condensations about two seconds of arc apart, and surrounded by a large, dim halo (Fig. 1). The spectrum of the galaxy is also remarkable. Superimposed on the faint continuous background from the hosts of member stars there are many diffuse emission lines, attributed to forbidden transitions (Fig. 2). According to W. A. Baum, more than half of the visible light of the object is produced by emission lines. In this respect, the Cygnus galaxy differs radically from ordinary systems, such as M31 or the Milky Way, whose spectra exhibit weak emission lines and a relatively strong continuum.

Baade and Minkowski, in 1954, explained the pair of condensations as two separate galaxies in the act of colliding nearly face on. Their motion relative to each other would make an angle of about 45 degrees to the line of sight. Earlier, in 1951, Baade and L. Spitzer, Jr., had computed the chances of collisions between galaxies. The probability that a particular field galaxy will collide with some other one is extremely small. In dense clusters of galaxies, however, such encounters should be much more frequent.

Thus, when Baade and Minkowski discovered that the Cygnus A object is actually one of the brightest members of a remote, rich cluster of galaxies, it seemed not unreasonable to suggest that it is a pair of galaxies undergoing a collision. Since each of the two systems may be of the order of 100,000 light-years in diameter, and the relative velocity perhaps 3,000 kilometers per second, it might easily take something like a million years for one galaxy to pass through the other.

"As far as the stars of the colliding systems are concerned," the Palomar astronomers wrote in 1954, "such a collision is an absolutely harmless affair. The average distance between two stars is so large that the two galaxies penetrate each other without any stellar collisions. The situa-

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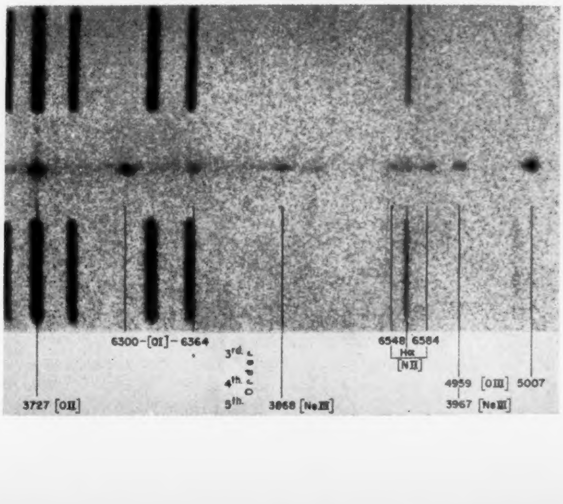


Fig. 2. The spectrum of Cygnus A, recorded by W. Baade and R. Minkowski with the 200-inch telescope. Very bright lines of ionized oxygen, nitrogen, and neon make this spectrum quite abnormal for a galaxy. The Palomar astronomers used a grating spectrograph, giving overlapping orders. From the "Astrophysical Journal."

tion is very different for the gas and dust embedded in the two systems. Because of the much shorter free paths of the gas and dust particles, the collision of the two galaxies means a real collision of the imbedded gas and dust, which are heated up to very high temperatures, since the collisional velocities range from hundreds to thousands of kilometers per second."

The hypothesis of colliding galaxies as strong radio sources has since been the subject of many investigations, and until recently most astronomers adopted it. Some doubt arose when radio astronomers observed that the centimeter and meter emission of Cygnus A does not come from the pair of condensations, but from two large blobs, located about 80 seconds of arc (some 250,000 light-years) to either side of the optical object. No visible light is associated with these blobs. The optical feature itself has a longest diameter of only about 30 seconds of arc (90,000 light-years).

In November, 1959, Minkowski rediscussed the problem of Cygnus A when the National Academy of Sciences met at Indiana University. There he stated: "This difference of optical and radio appearance does not contradict the identification. . . . [It has] now become strikingly clear from unpublished investigations by Bolton of the source Centaurus A, whose identification with NGC 5128 cannot be doubted." In both cases, there are optically unobservable sources of radio emission, symmetrically placed with respect to the optical object. For Centaurus A, the two radio blobs are each about four degrees from NGC 5128, or approximately $1\frac{1}{2}$ million light-years.

The Soviet radio astronomer I. S. Shklovsky had accepted the colliding-galaxy hypothesis in his book, *Cosmic Radio Waves,* whose English translation, containing its author's revisions, was published earlier this year. He gives an important analysis of the phenomena that would result from the encounter of two galaxies, each surrounded by a spherical halo of exceedingly tenuous but hot gas. When the outer edges of the halos

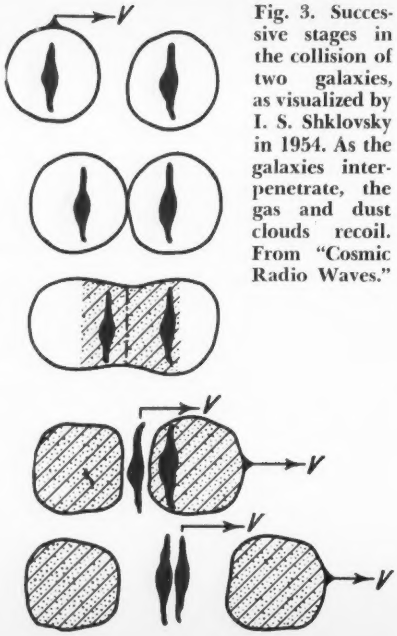


Fig. 3. Successive stages in the collision of two galaxies, as visualized by I. S. Shklovsky in 1954. As the galaxies interpenetrate, the gas and dust clouds recoil. From "Cosmic Radio Waves."

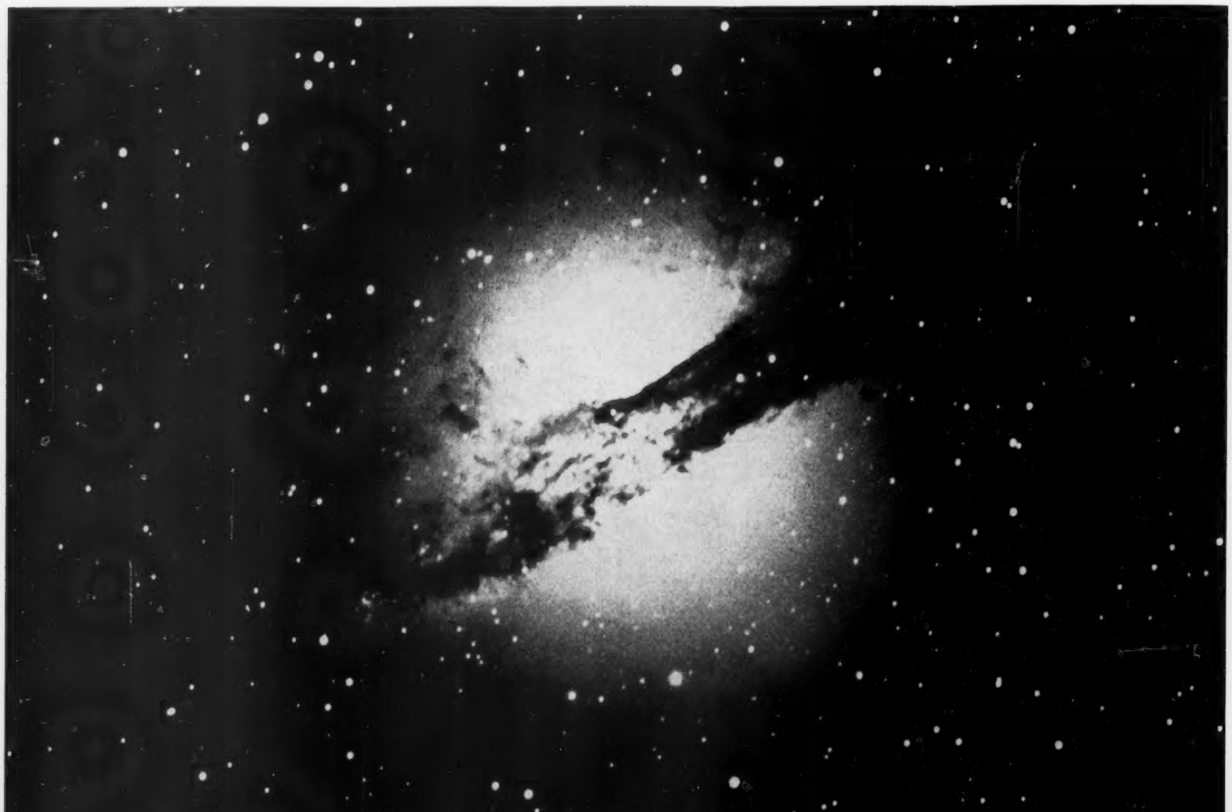


Fig. 4. The intense southern radio source Centaurus A is associated with this unusual elliptical galaxy, NGC 5128. Minkowski has called this two galaxies in collision, interpreting the dark band as a spiral seen edge on. Shklovsky, however, thinks it a single galaxy with an obscuring belt, and suggests that remote Cygnus A would appear similar, if it could be viewed from nearby. Hale telescope photograph from Mount Wilson and Palomar Observatories.

clashed, a hydrodynamic wave would be propagated rapidly through the gas, causing the appearance of many high-energy charged particles (Fig. 3). Their velocities, in the case of electrons, would approach the speed of light. Such so-called relativistic electrons produce strong radio waves.

In his book, Shklovsky calculated from the assumed density of the halos and their relative velocity that the kinetic energy of the Cygnus A colliding gas masses is 5×10^{59} ergs. The radiation rate is approximately 2×10^{44} ergs per second – most of it as radio emission. He supposed that the collision has been going on for about 10 million years, which would mean that some 5×10^{58} ergs have already been radiated away, approximately 10 per cent of the available kinetic energy.

All this seemed reasonably consistent with the state of our knowledge in early 1960. However, in an article about to appear in the *Russian Astronomical Journal,* Shklovsky has changed his position and now proposes a new interpretation of Cygnus A. I am grateful to Professor Shklovsky for an advance copy of his manuscript.

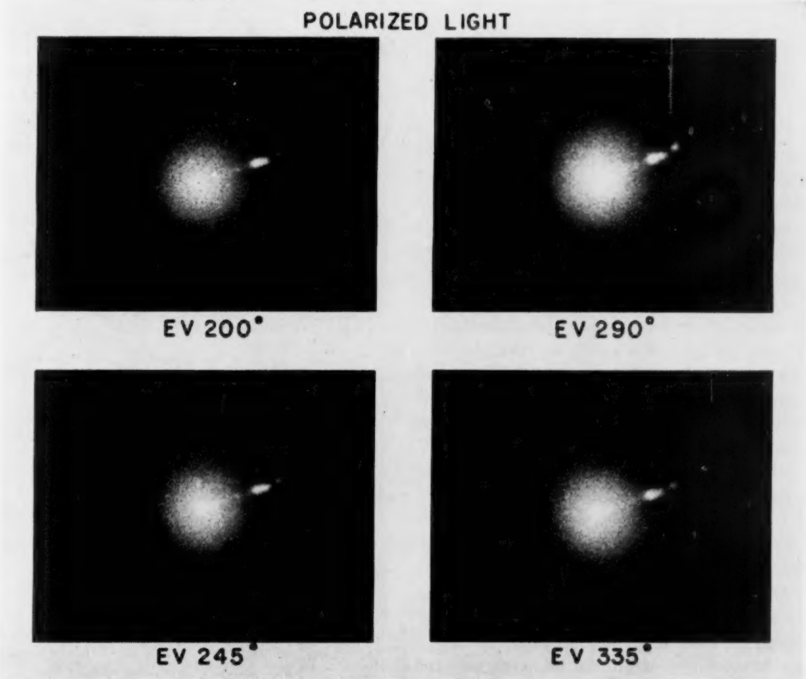


Fig. 5. From the nucleus of NGC 4486 (M87) extends a beaded ray that is highly polarized. These Hale telescope views, taken in polarized light of four orientations (electric vector marked), differ in appearance.

He and other astronomers had felt concern about the identification of several radio sources, notably Centaurus A, which Baade and Minkowski had linked with NGC 5128. That galaxy is near enough for detailed photographs (Fig. 4). A few years ago, it was widely regarded as a pair of colliding galaxies – a spherical one and an edgewise spiral. The former was identified with the symmetrical bright body, the latter with the broad band of obscuration. This interpretation was, however, never considered fully convincing, despite Minkowski's defense of it in November, 1959.

Additional doubt was created in Shklovsky's mind by the magnificent recent interferometer work on Centaurus A by J. Bolton and his associates. Their radio mapping indicates that Centaurus A consists of at least three sources – the galaxy NGC 5128 itself and the two distant blobs (*Publications,* Astronomical Society of the Pacific, February, 1960, page 29). And Shklovsky did not know that C. M. Wade, at the National Radio Astronomy Observatory, had recently discovered a new radio source, not far from Virgo A, that seems from preliminary data to be a close counterpart of Centaurus A. Optically, Wade's source is also an elliptical galaxy with a band of obscuration across it. If anything, this discovery tends to augment the doubts expressed by the Soviet astronomer.

During the past few years, several other strange galaxies have been found to be sources of strong radio emission (for example NGC 4486, associated with Virgo A), but the radio emission does not come from the brightest part of the optical feature. NGC 4486 shows no indication of collision; instead, from its nucleus a luminous straight jet extends in position angle 290 degrees (Fig. 5). Photographs of this jet show several condensations whose light is strongly polarized, each condensation having a different angle of polarization.

In his new paper, Shklovsky has marshaled several arguments against the collision hypothesis for Cygnus A. Consider first the problem of the energy involved. If the radio emission of Cygnus A is produced by the synchrotron mechanism, the total energy contained in the relativistic electrons is about 5×10^{60} ergs, a result based on independent computations by Shklovsky and G. R. Burbidge.

Where can this enormous amount of energy come from? The optically observed galaxies may contain 200 billion solar-type stars, with a combined mass of 4×10^{44} grams. The corresponding nuclear energy is given by Einstein's famous formula as the product of the total mass by the square of the velocity of light – 4×10^{65} ergs. However, only about one per cent of this energy can be released by known nuclear processes, unless we assume that the complete annihilation of mass and its conversion into energy are occurring in galaxies. And of this one per cent, only a minute fraction would appear as kinetic energy, with very little of that becoming radio emission.

As a second argument, Shklovsky points out that the optical spectrum of the Cygnus A object does not show double emission lines, as might be expected in the case of colliding galaxies. Instead of the relative velocity of 3,000 kilometers per second he assumed in his book, he now argues with considerable emphasis that the spectra by Baade and Minkowski suggest a relative velocity of only some 100 or 200 kilometers per second. Since the kinetic energy is proportional to the square of the relative velocity, it becomes perhaps 400 times smaller than the 5×10^{59} ergs he had given in the book. If so, the kinetic energy of a collision would be insufficient to maintain the radio emission of Cygnus A over the past 10 million years.

A third line of argument follows from Shklovsky's belief that each of the two galaxies of Cygnus A has an absolute magnitude of the order of -21. They would thus be giant systems, at least as large and as massive as the Milky Way and M31. Shklovsky therefore agrees with V. A. Ambarzumian that in this case the probability of collision as computed by Baade and Spitzer does not apply. The two American astronomers had considered average galaxies, but even in as dense a cluster as the Cygnus one, the probability of observing at the present time a collision between two extremely large galaxies is vanishingly small, because such objects are relatively rare.

These and other discrepancies have led Shklovsky to a new interpretation of Cygnus A. He now suggests that the apparently double optical object is not two colliding galaxies, but is a peculiar single galaxy resembling NGC 5128, with a broad band of obscuration across it.

If this view is correct, then Cygnus A and Centaurus A are very much alike,

but differing greatly in distance, since the first is 700 million light-years away, the other only 20 million. The two systems also differ in evolutionary age, according to Shklovsky, Cygnus A being intrinsically a much more powerful emitter of radio waves. From the synchrotron mechanism he estimates that Cygnus A may be only a few tens of millions of years old, while the age of Centaurus A may be between one and three billion years.

The source of the radio emission of both galaxies is attributed to tenuous gas clouds ejected from supernovae that exploded during the early stages of the two systems. The supernovae would have occurred in their central regions, where the stars are very strongly concentrated. The ejected clouds of gas, moving along magnetic lines of force from the nucleus of each galaxy toward its poles, would produce large numbers of the relativistic electrons that give rise to synchrotron radiation.

Shklovsky suggests that all galaxies undergo this stage of evolution relatively early in their histories. If so, some five or 10 billion years ago our Milky Way galaxy and M31 would have been intense radio sources similar to Cygnus A or Centaurus A, for only in the youngest galaxies would this be likely to occur.

The Moscow radio astronomer does not attempt to explain in his article the details of what happens when two galaxies really collide. Baade and Spitzer's calculations of the probability of collisions are not challenged; in fact they have been confirmed by G. A. Harrower in the *Astrophysical Journal* for July, 1960. Astronomers throughout the world will be awaiting new observational and theoretical discussions of the exciting ideas raised in Shklovsky's article.

ASTRONOMY IN THAILAND

Chulalongkorn University in Bangkok, Thailand, has recently enlarged its curriculum to include astronomy. Seeking to develop the program, Lt. Gen. Phya Salwidhannidhes, professor of engineering, conferred with astronomers at Harvard Observatory during his visit to the United States in September and October as a participant in the foreign leaders program of the Department of State. He is currently president of the Science Society of Thailand.

PEKING PLANETARIUM

Since its opening in September, 1957, the Zeiss planetarium at Peking, China, has had an average daily attendance of over 2,000 persons. There are five to seven scheduled demonstrations daily, and eight or nine on holidays. In the same building are an astronomical museum and a lecture room seating 500, while a neighboring dome contains a 5-inch refractor. The director is Lu Shu-yuan.

LETTERS

Sir:

Observational astronomy has long been harassed by the results of population growth and increased industrialization. Recently a new and potentially more serious threat has arisen.

Last July 6th, I was reassured by the National Aeronautics and Space Administration that the Echo I satellite would have a "relatively short" life. Now it appears that Echo I may be in orbit for a number of years, and the launching of an Echo II is planned for late this year. The orbiting of as many as 50 of these balloons has been proposed.

Admittedly Echo I not only has scientific but prestige value. However, if more of these bright objects are placed in similar orbits, there may be significant interference with some astronomical research. For example, long-exposure photography, especially with wide-field instruments, could be hampered.

A large number of slow-moving bright objects would markedly change the appearance of the sky and could only cause its disfigurement. Whether any group of people has the right to change the appearance of the night sky is questionable. Much fainter satellites have been successfully tracked, and I can see no useful purpose in having Echo satellites so bright. Blackening them might help.

Other potentially harmful proposals include orbiting or placing high in the atmosphere various particles, gases, and dusts. Unfortunately, once such objects are in orbit nothing can be done about them. Letters sent to members of Congress and to NASA right now should bring more careful thought and action to the problem. Only by immediate attention can we preserve what is so important to us.

ALAN McCLURE
649 S. Olive St.
Los Angeles 14, Calif.

Sir:

During several passes of the Echo I balloon satellite in August and early September, I found that it twinkled very rapidly. This phenomenon was seen in 7 x 50 binoculars, shaken to cause the satellite's image to trace out a curve. The traces were broken into short segments, showing that the light was varying on the order of 100 times per second. The frequency could be judged by comparison with a distant fluorescent light viewed in the same manner. Such a lamp on 60-cycle current flashes 120 times a second.

On one occasion, I viewed the balloon through a 6-inch telescope, and found that it did not appear to twinkle, even when the telescope was shaken.

These observations can be explained in terms of atmospheric turbulence and the satellite's rapid motion. Scintillation of stars is known to be caused by very slight variations of air density, on a scale of only a few inches, in the lowest mile or so of the atmosphere. Pockets of denser or lighter air act as positive or negative lenses of very long focus, alternately increasing and decreasing the intensity of the starlight reaching the observer.

The 100-foot aluminized balloon serves as a convex mirror, giving essentially a point image of the sun. Hence the density fluctuations must have been enough smaller than the 6-inch telescope mirror for their effects mostly to cancel out. On the other hand, the fluctuation scale was evidently larger than the small effective diameter of the binocular objectives.

When Echo I, traveling about 4.5 miles per second, is moving perpendicularly to the line of sight, a ray of light from it to the observer's eye cuts through the atmosphere with a velocity of 24 feet per second at a height of one mile. If the scale of the density fluctuations is three inches, the resulting twinkling would have a frequency of nearly 100 per second, in plausible agreement with my estimate of the observed rate in binoculars.

WILLIAM D. ROSS
120 Birch Ave.
Wilmington 5, Del.

Sir:

Although astronomical equipment is rather scarce in our country, there are 700 members in the Yugoslav Astronomical Society. We publish a quarterly magazine *Vasiona (Universe),* written largely by staff members of the Belgrade Astronomical Observatory.

We believe there may be some amateurs in the United States who would like to read astronomical articles in Serbian. Since our funds are limited, we would appreciate a subscription to SKY AND TELESCOPE in exchange for *Vasiona.* We can also send another publication, *Zemlja i Svemir (The Earth and the Universe),* a quarterly printed by the Zagreb Astronomical Observatory.

DRAGOSLAV EKSINGER
Koce Kapetana 44/III
Belgrade, Yugoslavia

ALICE FARNSWORTH DIES

A well-known teacher of astronomy at Mt. Holyoke College from 1920 to 1957, and director of its Williston Observatory since 1936, Alice H. Farnsworth died on October 1st at Newton, Massachusetts. Born in Williamstown, she was 66. Her doctorate in astronomy was from the University of Chicago, and she had worked at Lick Observatory.

Dr. Farnsworth served as president of the American Association of Variable Star Observers from 1929 to 1931. She was a regular observer of occultations and sunspots, in collaboration with her students. In addition, she published several papers on the distribution of stars in space, and on the absorption of starlight by interstellar dust.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 106th meeting of the American Astronomical Society at Mexico City, August 22-25, 1960. Complete abstracts will appear in the Astronomical Journal.

Rotation of Stars in Orion

An important difference has been found by D. H. McNamara, Brigham Young University, between the *B*-type stars belonging to the Orion association and similar stars that are scattered over the sky.

Dr. McNamara measured the rotational velocities of 28 stars from the broadening of their spectral lines. All 28 had spectral types between *B*0.5 and *B*3, and all but four were main-sequence objects. For any individual star, he could not tell whether low rotational velocity is an intrinsic property, or whether that star's axis of rotation happens to be tilted toward the earth. But he could establish, for the stars as a group, that they are spinning with an average velocity of 126 kilometers per second. This result assumes the stars' axes are oriented at random.

Earlier, a similar study of 67 *B*1 to *B*3 field stars had been made at Perkins Observatory by A. Slettebak and R. Howard, who found an average rotational rate of 200 kilometers per second. It is not known why the *B* stars belonging to the Orion association rotate so much more slowly.

High-Altitude Balloons

For astronomers interested in placing their instruments well above most of the earth's atmosphere, James R. Smith of Raven Industries, Inc., suggested an increased use of high-altitude plastic balloons, such as employed in Project Stratoscope to observe granulation on the sun. He described these carriers and explained what they can do.

Currently, maximum payloads of 2,500 to 3,500 pounds are being lifted successfully. By using the largest balloons available, these loads can be carried above 100,000 feet, but Mr. Smith pointed out that smaller sizes (perhaps two million cubic feet instead of 10 million) can serve reliably to carry loads to 80,000 feet and be well within the proven limits of balloon operation.

One serious limitation has been that surface winds are often too strong to permit launchings at will. But at Holloman Air Force Base in southern New Mexico (near Sacramento Peak Observatory), a long-term study indicates that satisfactory balloon launching conditions occur on more than four days in five.

A new result from the Project Stratoscope flight of August 17, 1959, was reported by J. D. R. Bahng and M. Schwarzschild, Princeton University Observatory. They studied an eight-minute sequence of high-definition photographs of the sun's surface, and found the average lifetime (as technically defined) of solar granules to be 8.6 minutes, with a probable error of ± 0.2 minute.

Chemistry of Jupiter's Atmosphere

Recent laboratory experiments to provide new information about the chemistry of planetary atmospheres have been undertaken by Carl Sagan, Yerkes Observatory, and Stanley L. Miller, University of California.

In one type of experiment, they passed electric corona discharges through mixtures of hydrogen, methane, and ammonia in the proportions of 30:3:1, this being roughly the composition of Jupiter's atmosphere above the cloud layer. The gas mixture was allowed to stand until equilibrium was attained, and then samples were extracted for analysis with an infrared spectrograph and a mass spectrograph.

The molecules produced in this way included ethane, ethylene, acetylene, hydrogen cyanide, acetonitrile, and formaldehyde, the last being formed only when water vapor was present. The experimenters point out that these results disprove the statement frequently encountered in astronomical literature that more complex molecules cannot be produced from methane and ammonia in an excess of hydrogen.

Inclusion of hydrogen cyanide in the list is interesting, since G. P. Kuiper has observed a feature in the infrared spectrum of Jupiter, at a wave length of 1.53 microns, which has been tentatively identified as due to HCN.

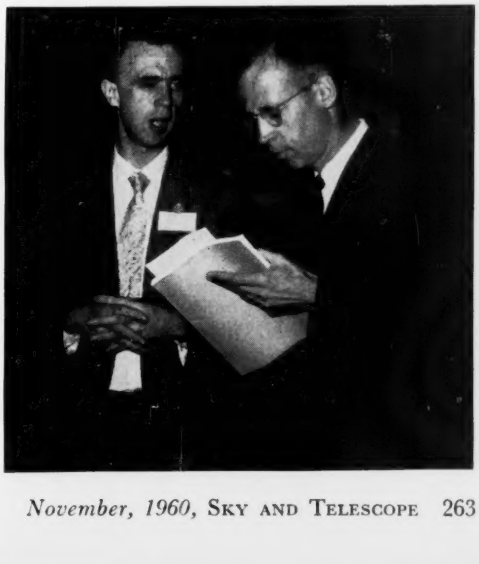
The possible presence of acetylene on Jupiter is suggestive, since this gas is known to polymerize explosively under conditions similar to those in the planet's atmosphere, forming a variety of compounds of high molecular weight, some of them strongly colored. This may have bearing on the colorations observed in Jupiter's belts, and it is also possible that such chemical reactions may contribute to Jupiter's radio noise.

Stellar Aluminum Oxide

Among the many absorption bands in the spectra of the cool red stars of type *M* are some due to molecules of aluminum oxide. Under the conditions of temperature and pressure in stellar atmospheres, however, this compound has the composition AlO, rather than the Al_2O_3 familiar on earth. Peculiarities in the behavior of stellar aluminum-oxide bands were described in a paper by Philip C. Keenan, Perkins Observatory.

The bands usually appear as absorption features in long-period variable stars, and as weaker absorptions in ordinary *M*-type giants and small-amplitude red variables. They are stronger in the coolest *M* stars. Using the Perkins 69-inch reflector, Dr. Keenan and his colleagues have made a

In the picture at the left, Rupert Wildt of Yale Observatory talks astronomy with Rudolph Minkowski, Mount Wilson and Palomar Observatories, in the science-auditorium foyer of the Mexican National University. At the right, Arthur N. Cox of Los Alamos Scientific Laboratory converses with Lick Observatory astronomer George H. Herbig, who is holding the abstracts for papers given at the meeting. Photographs by David Tellez.



Among the many small groups that gathered between sessions at Mexico City were the two shown here. At the left, Smithsonian Astrophysical Observatory astronomers (from left to right) Jack W. Slowey, Don A. Lautman, and Leon Campbell, Jr., talk with former associate Karl G. Henize, now at Dearborn Observatory. At the right are Henrietta H. Swope and A. H. Joy, Mount Wilson and Palomar; Helen Pillans, Mills College; and Mrs. Joy. Photos by D. Tellez.

survey of the spectra of 60 long-period variables, finding that aluminum-oxide features differ from star to star. R Hydrae, RT Librae, and SU Virginis have unusually strong AlO absorption bands, but they are weak in RT Cygni.

A hitherto unique anomaly occurred in the spectrum of Mira for several weeks in 1924, when the blue bands of aluminum oxide appeared in emission. Now Dr. Keenan reports that the same event occurred in the spectrum of R Serpentis during March, 1960. This variable passed through a maximum (magnitude 7.9) much fainter than average on March 20th, according to the American Association of Variable Star Observers. The 1924 maximum of Mira was also below normal, but both stars have had other faint maxima at which no AlO emission was observed.

One remarkable exception to the rule that aluminum-oxide bands are prominent only in late *M* stars was provided by the supergiant variable Rho Cassiopeiae, normally an *F* star, when it was unusually faint in 1946.

Zeta Aurigae Masses

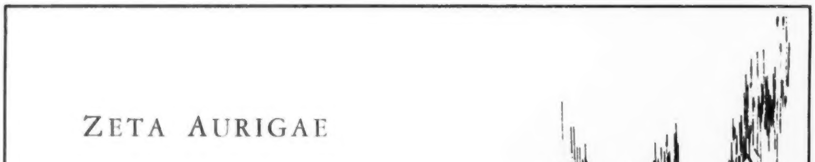
One of the most important eclipsing binaries is Zeta Aurigae, which consists of a blue star, spectral type *B*7, and a cool *K*4 star of very large dimensions. They revolve around each other in a period of about 32 months, and the *B* star is totally eclipsed by the other for 37 days. Although much is known about this system from its light curve and spectrum, the distance from us is uncertain and the masses are imperfectly established.

Now, at the University of California in Los Angeles, Daniel M. Popper has made a new mass determination by means of spectrograms obtained with the 100-inch Mount Wilson telescope expressly for his study. In all there are 35 spectrum photographs, strongly exposed in the near-ultraviolet region at 3700 to 4000 angstroms, with a dispersion of 10 angstroms per millimeter. At this large scale, microdensitometer tracings like the one shown here give a very detailed portrayal of the spectrum.

The broad dips in the tracing are the Balmer hydrogen lines of the *B* star, but superimposed on them and badly distorting them are the very numerous sharp lines of metals in the atmosphere of the *K* star. Dr. Popper sought a method of allowing for this distortion, so the true wave lengths of the *B* star's hydrogen lines could be measured and Doppler shifts determined for different positions in its orbit. In this way the motion of the *B* star could be obtained, while the velocity variations of the *K* component were already well known. Most of the spectrograms were obtained near times of extremes of velocity variation, that is, when one star was approaching us and the other receding, producing the maximum Doppler shift in their lines toward opposite ends of the spectrum.

In order to calibrate the method of reduction, 26 composite photographs of stars of known velocity were used. Each of these spectrograms consists of the superposed spectra of two stars of types similar to those of Zeta Aurigae's components. For each particular hydrogen line measured (H_ϵ, H9, H10, H12, H13, and H14), a correction to the observed position was obtained, thus making allowance for the distortion by the *K* star's metallic lines.

The provisional results for the masses are 7.9 for the *K* star and 5.5 for the *B* star, in terms of the sun's mass. The *B* component thus seems more nearly normal than was indicated by the value of 10.2 (22.0 for the *K* star) obtained by P. Wellmann in 1951. The estimated mean error of the new values is 15 per cent.



Daniel M. Popper's tracing of the spectrum of Zeta Aurigae was made from a 100-inch-telescope spectrogram. Courtesy University of California.

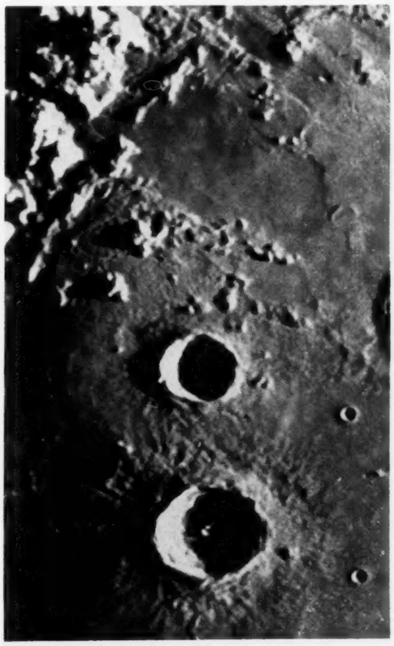
Lunik II's Landing on the Moon

ON the afternoon of September 13, 1959, as the Soviet rocket Lunik II was nearing the moon, the news agency Tass distributed a prediction that the object would strike the lunar surface at 21:01 Universal time, in the region between Mare Tranquillitatis, Mare Serenitatis, and Mare Vaporum. The forecast led many European observers to watch this area for visible signs of impact, such as a short-lived dust cloud. (At the time in question, the moon was still below the horizon for the United States.)

In the next few days a number of press notices reported optical observations of impact, but the evidence appeared unsatisfactory. There was disagreement on the location of the point of fall, and in most cases the details were lacking. Only the sudden cessation of the space probe's transmissions at the predicted time, and the analyses of radio tracking observations in the United States, Great Britain, Japan, and the U. S. S. R., demonstrated that Lunik had in fact reached the moon.

This situation has now been placed in an entirely new light by L. Detre, an internationally known astronomer who is director of the Budapest-Szabadsaghegy Observatory in Hungary. In No. 45 of the *Contributions* of that institution, he gives a full account of certain decisive observations in Hungary and Sweden.

At the Budapest Observatory, staff member M. Lovas was viewing the moon at the crucial time with the 7-inch refractor. The seeing was good, and he could use a magnification of 500. With him in the dome were two other staff astronomers, Julia Balazs and B. Balazs. Very shortly after 21:02:30 UT, Lovas said, "There is a dark point I did not see before." A few seconds later, he called out that the spot was expanding. Both his colleagues took a turn at the eyepiece, and were able to verify the expansion. As the spot grew, it faded, and was about 40 kilometers in diameter when it was last definitely seen, at 21:07.



Lovas estimated the position of the marking as close to a small crater plotted in the International Astronomical Union's lunar atlas at selenographic co-ordinates $\xi = +.024$, $\eta = +.434$. This is in Mare Imbrium, south of the crater Autolycus and not far from the Apennines, but somewhat outside of the predicted impact area of Lunik II.

The same dark marking was independently seen in a 10-inch reflector by M. Ill at the public observatory and satellite-tracking station of Baja, in southern Hungary. He devoted particular attention to fixing the location of the spot, whose co-ordinates he estimated as $\xi = +.03$, $\eta = +.45$, a position 25 kilometers northwest of Lovas'. Mr. Ill could keep the marking in view until 21:08. Because his observations were reported in Hungarian provincial newspapers the next day, before he could know of the details of the Budapest sighting, this appears to be an independent confirmation.

Also on the night of September 13th, a good series of lunar photographs was taken at Uppsala, Sweden, by E. Tengström, with the Markowitz moon camera of the university's geodetic institute. Professor Detre wrote to Uppsala to ask if these photographs showed any unusual feature at the co-ordinates +.024, +.434.

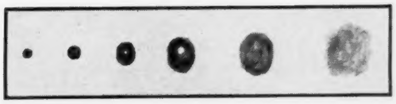
Tengström replied that he found nothing definite in that position, but *25 kilometers northwest* there seemed to be a very small, sharp, dark spot on his photograph of 21:03.6 UT, and a trace of it on the next exposure, taken 1.9 minutes later.

Professor Detre summarizes his conclusions in the following words:

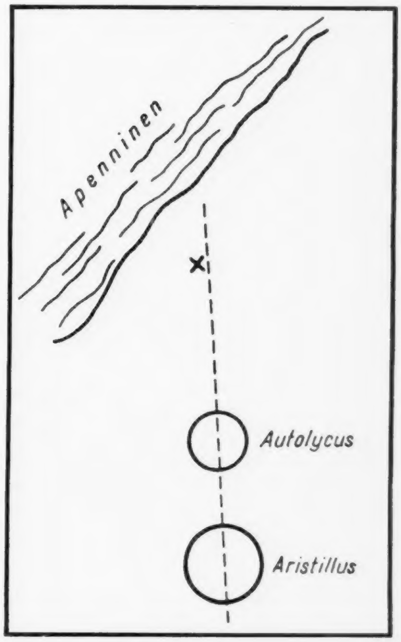
"1. Shortly after the radio signals from Lunik II ended, an expanding spot on the moon could be observed in the position +.03, +.45, which was at first black and pointlike, a few minutes later gray and diffuse, with a diameter of about 40 kilometers. The reality of the phenomenon is beyond doubt. It was most probably a cloud of dust.

"2. There is a faint photographic trace, still awaiting confirmation, of this phenomenon on the plates taken by Tengström in Uppsala, which should furnish a precise positional determination.

"3. The phenomenon observed by the Hungarian astronomers is the only one compatible with the impact point subsequently deduced by Soviet radio tracking of the instrument section of Lunik II."



The impact cloud of Lunik II, drawn by Budapest observers at one-minute intervals. One inch on this picture corresponds to about 50 miles.



In M. Ill's sketch map, right, his dark spot appeared at the place marked X. Most of the same area is shown on the Mount Wilson 100-inch-telescope photograph at the left. Both drawings on this page are from the "Contributions" of the Budapest-Szabadsaghegy Observatory in Hungary.

EAST-WEST EXCHANGE

An American solar astronomer is spending six months at the Crimean Astrophysical Observatory while a Soviet specialist in stellar astrophysics is working at the University of California, in an exchange program sponsored by the U. S. Department of State and supported by the Guggenheim Foundation.

The American is Harold Zirin, of the High Altitude Observatory in Colorado, who will study solar magnetic fields. His Soviet counterpart is Crimean astronomer A. A. Boyarchuk.

The ALPO exhibit at the Astronomical League meeting. Photo by the author.

Convention at Haverford

WILLIAM K. HARTMANN,

Allegheny Valley Amateur Astronomers Association

THERE were 278 registrants from 25 states, the District of Columbia, Canada, Puerto Rico, and Cuba at the 1960 convention of the Astronomical League, held over Labor Day weekend at Haverford College in Pennsylvania. Philadelphia's Rittenhouse Astronomical Society was the host, with Edwin F. Bailey as general chairman.

The meeting opened with a business session on Saturday, September 3rd. Mrs. Wilma Cherup, executive secretary, stated that the league had gained 16 new member societies, nine of them in the Northeast Region, during the past year. A description was given of league services now available to members. These include a manual for holding regional conventions, a 10-per-cent discount on astronomical books, and an information bureau on instruments. In the planning stage are filmstrips with lecture tapes, as well as manuals on preparing papers and organizing club projects.

Five talks were given at the first general session that afternoon, including an account by Miss E. T. Vadala of Philadelphia of her observing experiences in high-flying balloons, and a lively presentation by Dr. Earle G. Linsley of Honolulu, Hawaii, on Polynesian astronomical lore. This was followed by the motion picture Universe, a production of the National Film Board of Canada and winner of the animation prize at the Cannes, France, film festival. It is an introduction to astronomy, and shows with beautiful perspective numerous planetary and stellar animated sequences.

After the movie, a junior session was held. Among the speakers who were later awarded prizes for their presentations were Robert Kenison, Madison, Wisconsin; Charles Downton, Jr., and Robert Dragon, both of Springfield, Massachusetts. A proposed classification system for deep-sky objects by George Doschek and James Mullaney of Pittsburgh aroused much comment. Tim Wyngaard, Madison, concluded the program with an illustrated account of his trip to the Canary Islands with the United States solar eclipse expedition of October, 1959.

That evening three observatories were visited. On the Haverford campus, excellent views of Jupiter and Saturn were had through the instruments of the Strawbridge Memorial Observatory; passage of the Echo I satellite enlivened the star party. Nearby Villanova Observatory was open to delegates. John J. Ruiz, of Dannemora, New York, was one of those who was invited to the Flower and Cook Observatory by its director F. B. Wood. Mr. Ruiz's description follows.

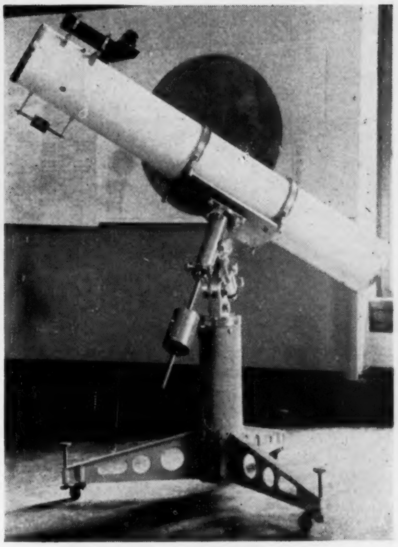
"The observatory is used exclusively for research work and is not ordinarily open to the public. This was a special demonstration of part of the electronic equipment for those amateurs who either had themselves built photometers and made photoelectric observations or who were seriously considering doing so.

"Mr. E. G. Reuning showed us the 28½-inch reflector, which has an infrared photoelectric photometer that utilizes lead-sulfide cells and works at wave lengths greater than 9000 angstroms. Appropriate filters isolate a region lying around 1.6 microns for brighter objects. The instrument is currently employed for measures of certain intrinsic and eclipsing variables, especially Algol.

"On the 15-inch horizontal refractor, Dr. William Blitzstein demonstrated a pulse-counting photometer that is being used by graduate students for multicolor observations of eclipsing systems. We were also shown a conventional direct-current photometer that is employed by L. Binnendijk and his students on the reflector, and the instruments for scintillation studies by W. M. Protheroe. We are in-

This convention group picture by Ray Satori is continued on the next page.

Seated at the head table for the honors dinner on Monday evening were, from left to right, Dr. Louis C. Green, Mrs. Chandler Holton, Mr. Holton, Edwin F. Bailey, Rev. Edward Jenkins, Mrs. Wilma Cherup, Manfred Kamintius, and Walter H. Haas. Photograph by Frank Delaney.



G. E. Audy, Wilmington, Delaware, built this 8-inch reflector for an amateur in the Canal Zone. Photograph by the author.

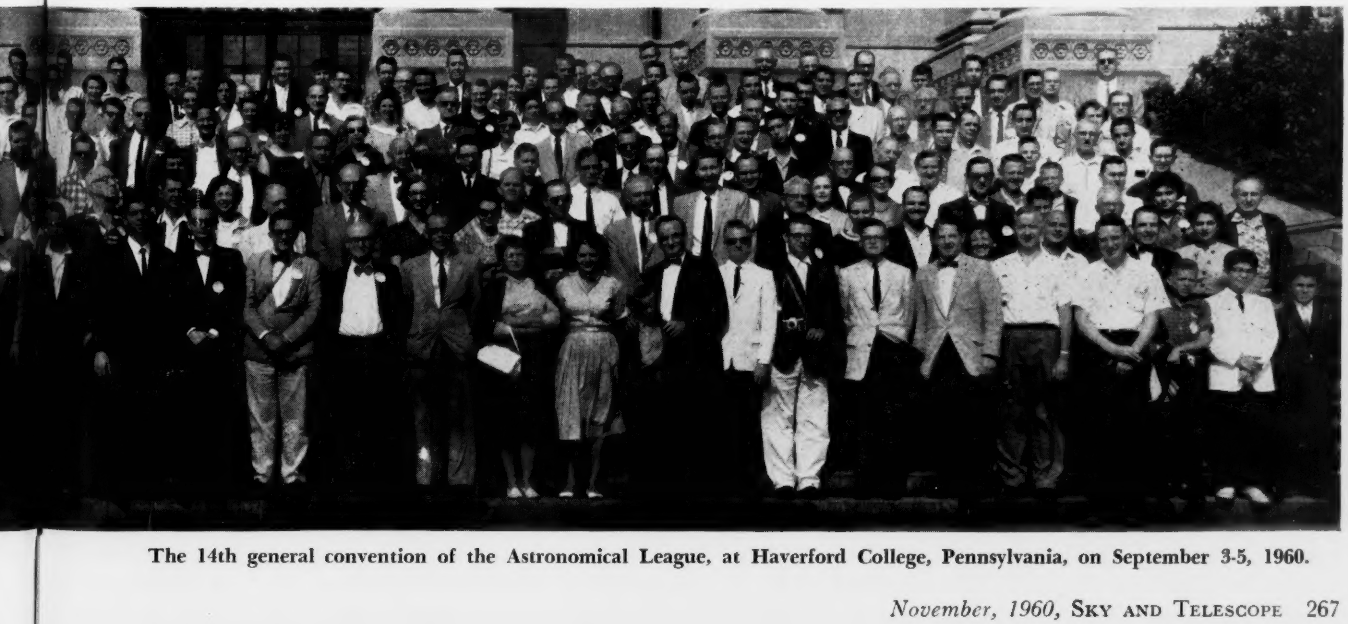
debted to Dr. Wood and Mr. Reuning for devoting so much of their time and patience in answering our many questions."

On Sunday, an all-day bus trip took the delegates from Pennsylvania to New Jersey, and into Delaware. The first stop was at the Franklin Institute for a showing of the Zeiss projector of the Fels Planetarium and inspection of the rooftop observatory. On the way to Edmund Scientific Company in Barrington, New Jersey, where a steak dinner was served, the buses passed such historical sites as Independence Hall and Betsy Ross house. Then the tour went to Spitz Laboratories in Yorklyn, where the new Spitz model A-3-P planetarium projector was unveiled. After a buffet supper given by the company, the buses left for Swarthmore, Pennsylvania, where the party inspected Sproul Observatory's 24-inch refractor, used for trigonometric parallax determinations.

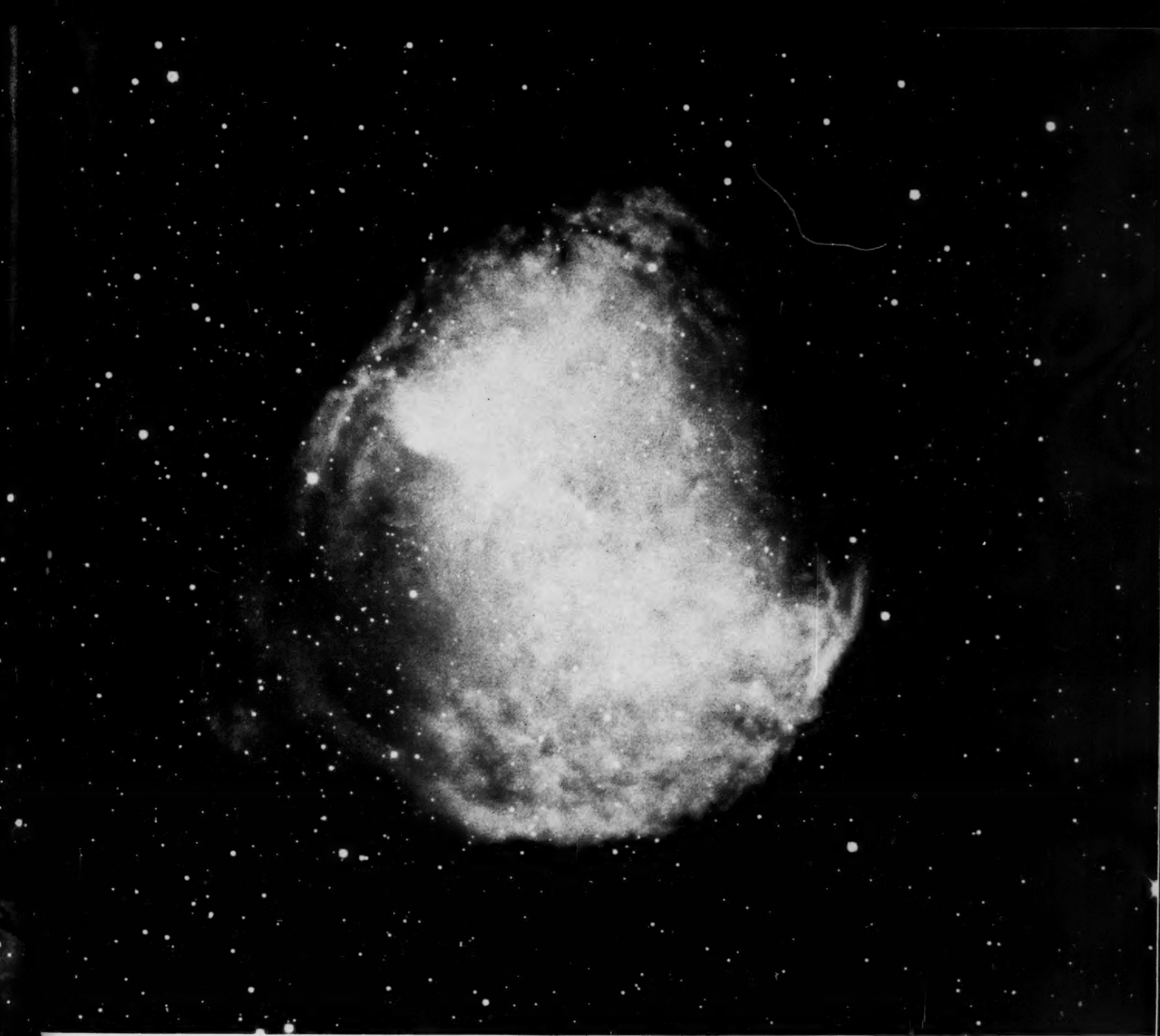
The Association of Lunar and Planetary Observers held its meeting on Monday morning, with Walter H. Haas, Edinburg, Texas, as chairman. The Jupiter recorder, Philip R. Glaser, of Menomonee Falls, Wisconsin, reported that a disturbance in that planet's south equatorial band seems to be imminent. According to Phillip W. Budine, Binghamton, New York, activity on Saturn was unusually great this year, a number of prominent long-lasting white spots having been observed in fairly high latitudes. At the league's instrument session that afternoon, seven papers were presented, ranging from a null test for paraboloids by Charles Spoelhof, Rochester, New York, to the Lehigh Valley Amateur Astronomical Society's planetarium project (Sky and Telescope, June, 1959, page 430).

At the final business meeting, the following officers were elected for the coming year: Norman C. Dalke, Seattle, Washington, president; Ralph K. Dakin, Pittsford, New York, vice-president; Dr. Herman C. Sehested, Ft. Worth, Texas, secretary; and Leonard G. Pardue, Miami Springs, Florida, treasurer. The Middle East Region named the following officers: David D. Meisel, Fairmont, West Virginia, chairman; Anthony Doschek, Pittsburgh, vice-chairman; Emil Volchek, Wilmington, Delaware, secretary; and Edward Naylor, Harrisburg, treasurer. Detroit, Michigan, will be the site for the 1961 convention, which will be held over the July 4th weekend.

The closing event was the honors dinner on Monday night. Daniel Kleinman, Louisville, Kentucky, was named the outstanding junior of the year, and an ALPO award was presented to Mr. Meisel. The banquet speaker was Dr. Louis C. Green, of Haverford College, who talked on extending observational astronomy beyond the earth's atmosphere.



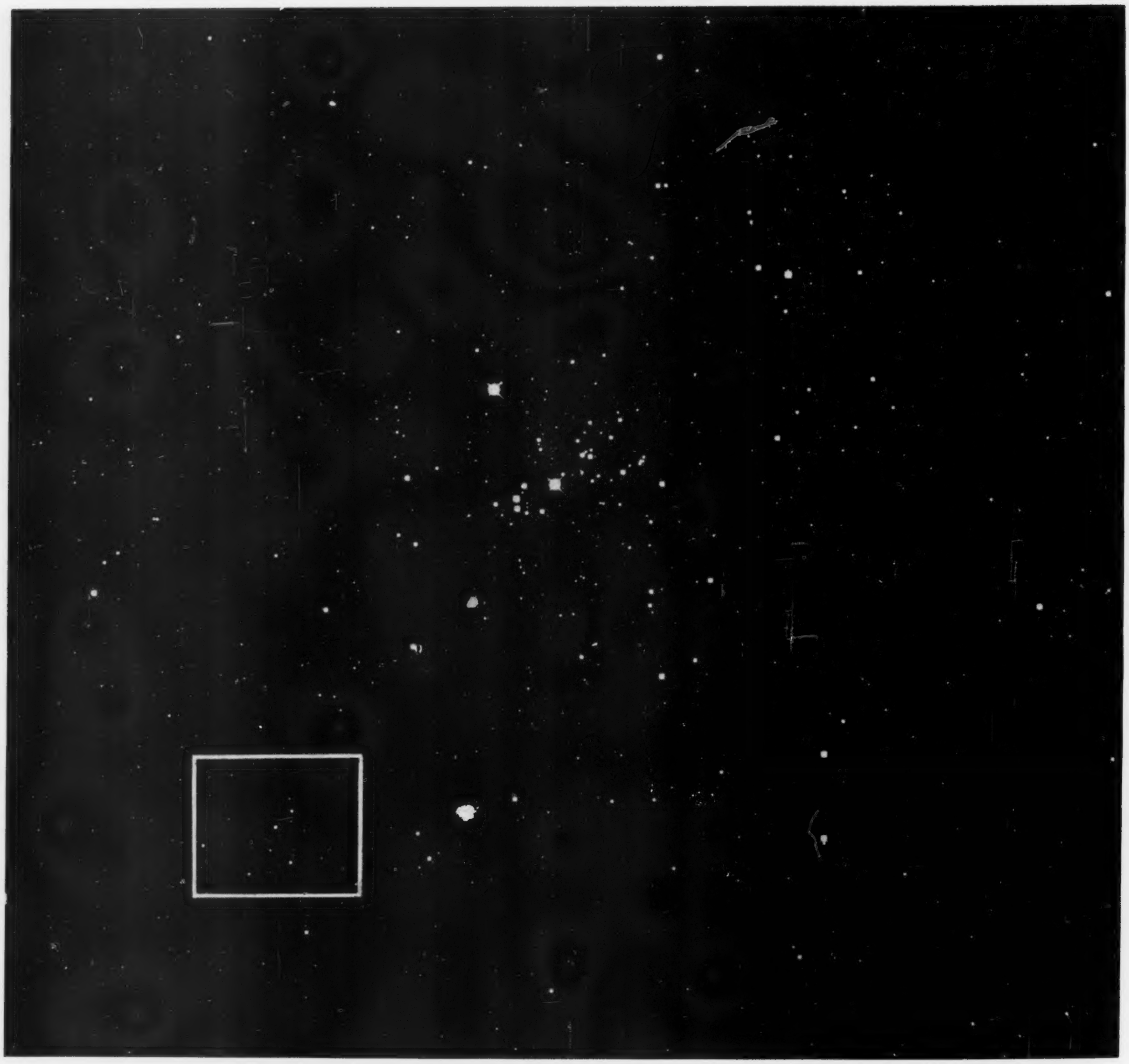
The 14th general convention of the Astronomical League, at Haverford College, Pennsylvania, on September 3-5, 1960.



Lick 120-inch Photographs—V

FACING PAGE: This great gaseous nebula in Serpens was photographed in a 40-minute red-light exposure with the 120-inch Lick Observatory reflector by N. U. Mayall on July 20, 1960. The emulsion was Eastman 103a-F and the filter OG1. North is at the left, west above, and the scale is 4.1 seconds of arc per millimeter. The open star cluster to the left and above center is Messier 16, whose distance from us is nearly 4,000 light-years. Noteworthy are the many, very small, black globules scattered over the nebula, some fine examples being situated on the southeastern outskirts of M16. These compact dust clouds may be condensing to form stars; their reality can be verified by a comparison with the photograph taken by the 200-inch telescope and reproduced on pages 246-7 of the August, 1951, issue. There Otto Struve discusses the problem of "Clouds with Silver Linings," since this nebulosity is also remarkable for the bright-rimmed lanes of obscuring material that extend into it from many sides.

ABOVE: Messier 27, the famous Dumbbell nebula in the constellation of Vulpecula, is one of the largest and brightest planetary nebulae in the sky. An enormous expanding cloud of highly rarified gas, it is excited to shine by a faint but very hot central star. Its distance is estimated at 1,000 light-years. Dr. Mayall obtained this photograph with the 120-inch telescope on June 23, 1960, a 15-minute exposure on a 103a-O plate. North is toward the bottom in this reproduction, which has a scale of 3.1 seconds of arc per millimeter. The nebula is a difficult object for pictorial photography because of the great range in luminosity between the dim outlying parts and the bright central regions, whose flocculent structure is well shown here. Compare this view with the drawing ("Sky and Telescope," October, 1959, page 665) made in 1860 by William Lassell from visual observations with a 48-inch reflector. These photographs and those on the next page are courtesy Lick Observatory.



The large-scale picture above is of h Persei (NGC 869), the western member of the Double Cluster in Perseus, as shown in a five-minute exposure with the 120-inch reflector. It was taken December 19, 1959, by N. U. Mayall, using Eastman 103a-E emulsion and an RG1 filter for red light. The Double Cluster is at a distance from us of 7,300 light-years. In an f/5 mirror, the field of sharp definition is small, and all stars not close to the optical axis show fan-shaped images, distorted by coma. Hence, the 120-inch telescope has a correcting lens, placed a short distance in front of the photographic plate, and this negative was exposed through it. The effectiveness of the corrector is indicated by the neatness and roundness of the star images in the boxed area (enlarged fourfold at the left), which is about 15 minutes of arc southeast of the cluster center. The fine quality of the big Lick instrument is further shown by its light grasp, for in a 30-minute exposure on fast blue-sensitive plates, stars close to photographic magnitude 23 are recorded. Pictures made under the most favorable conditions allow images of galaxies to be distinguished from stars to as faint as about magnitude 22½. This impressive performance is surpassed only by the 200-inch telescope on Palomar Mountain.

NEWS NOTES

PLANETARY ORIGIN AND LITHIUM ABUNDANCES

The cosmic distribution of the third lightest element, lithium, is far from uniform. In the sun it is relatively less abundant than on earth. Recently, W. K. Bonsack and J. L. Greenstein have found that the T Tauri stars are abnormally rich in lithium, the surfaces of these stars having at least 10 times as much of this element per gram of material as do the nebulae surrounding them (see August issue, page 81). These facts have now led Thomas Gold, Cornell University, to discuss their bearing on the problem of the origin of the solar system. In the *Astrophysical Journal* for July, he writes:

"It has often been suggested that the planetary material may once have been part of the sun in the form of an outer envelope that was later thrown off and that then, perhaps through magnetic interaction, it obtained almost all the angular momentum initially resident in the sun. Such a thin, far-flung disk of gas may then have condensed into the planets. The lithium evidence would now strongly suggest that this indeed has been the course of events. The sun in its early stage would, as a consequence of shedding its magnetic energy, have formed an atmosphere rich in lithium just like the T Tauri stars presently observed and then, in forming a planetary disk out of this material, would have assured the high lithium abundance in the eventual planets."

Dr. Gold points out that if stars generally go through a T Tauri stage and then shed their atmospheres rich in lithium (and possibly deuterium), we might identify by spectroscopic means a small nebula around some such star. This case would then be similar to the solar system before the formation of planets.

COPERNICUS AND CALVIN

After the death of Copernicus in 1543, his doctrine of planetary motions around the sun gained only gradual acceptance, and for a century it was the source of religious as well as astronomical controversy.

It is well known that Martin Luther was a severe critic of Copernicus, and the same is often said of John Calvin (1509-64), the French Protestant reformer at Geneva, Switzerland.

The question of Calvin's actual views on astronomy has recently been carefully surveyed by Edward Rosen, City College of New York, in the *Journal of the History of Ideas* (July-September, 1960). Dr. Rosen shows that the astronomical allusions in Calvin's writings are pre-Copernican. Far from being an opponent of Copernicus, Calvin probably was unaware of the Polish astronomer's work.

The legend that the Genevan reformer was a critic of Copernicus originated, according to Dr. Rosen, in a mistake by the English ecclesiastical writer F. W. Farrar (1831-1903).

INVITATIONS TO BERKELEY IAU MEETING IN 1961

Attendance at the August, 1961, meeting of the International Astronomical Union will be restricted to its members and invited guests. Invitations to nonmembers are to be limited to the following categories:

1. Astronomers who are being proposed for IAU membership. 2. New astronomers who are potential members. 3. Outstanding scientists in other fields who have wide astronomical interests.

The U. S. national committee of the IAU has asked astronomy departments to nominate the top 10 per cent of their graduate students for invitations under category 2, also recent recipients of the doctoral degree if they are deemed potential union members. Persons in the third category should be recommended by two members.

Correspondence concerning invitations should be sent promptly to Dr. Frank K. Edmondson, Goethe Link Observatory, Indiana University, Bloomington, Ind.

CHRISTMAS MEETINGS

On December 28-31, the American Astronomical Society will hold its 107th meeting, together with Section D of the American Association for the Advancement of Science. The sessions for papers are open to all persons registering for the 127th AAAS meeting, which takes place in New York City December 26-31. The astronomical headquarters are to be at the Hotel Roosevelt.

The program features a joint symposium to be held with Section B (physics), "Plasma: the Fourth State of Matter," on Wednesday morning, December 28th. The next day, when AAS paper sessions begin, Dr. Ira S. Bowen, director of Mount Wilson and Palomar Observatories, is scheduled to give the address of the retiring chairman of Section D. That evening, the Helen B. Warner lecturer will be Halton C. Arp, also of Mount Wilson and Palomar.

NEW YORK PLANETARIUM'S 25TH ANNIVERSARY

On October 2nd, the American Museum-Hayden Planetarium marked completing its first 25 years of operation. Members of the original 1935 staff were invited to a banquet and showing of the current demonstration, "20,000 Leagues Above the Seas," the Sunday evening public audience partaking of coffee and dessert after the performance.

Attendance at the planetarium in its first year was more than 600,000, a figure not exceeded until the opening of the satellite era three years ago. Early this year extensive improvements in the physical plant were made, including the installation of theater-type seats and a new Zeiss projector (SKY AND TELESCOPE, March, 1960, page 271). Further plans call for addition of a new wing to the building with exhibit space, classrooms, an enlarged library, and a research laboratory.

IN THE CURRENT JOURNALS

INTERFERENCE FILTERS, by D. M. Hunten, *Journal* of the Royal Astronomical Society of Canada, August, 1960. "The first interference filters were made about 20 years ago by Geffcken of the Zeiss firm, but they did not see much application until some time after the war. Their advantages over conventional absorption filters are that they can isolate a very narrow region of the spectrum and that this region can be at any desired wave-length."

SURVIVAL POSITION LOCATION USING STAR SIGHTING, by E. H. Sharkey, *Navigation*, Vol. 6, No. 8, 1960. "A method using star sighting which can be used by persons having no knowledge of celestial navigation has been developed and tested. Neither sextant nor almanac is required. The necessary equipment fits into a shirt pocket and provides an accuracy of 10 to 20 miles under realistic field conditions."

ASTRONOMERS IN TURMOIL, by Otto Struve, *Physics Today*, September, 1960. "The explosion which we are witnessing today is mainly due to the sudden recognition by our people of the importance of what the popular writers call the conquest of space. . . . But I believe we are in fact living in a period of vigorous, though much more gradual, increase of ideas, which has little or no relation to the sputniks and which began in the early years of this century. . . ."

PHENOMENA OF THE SOLAR ATMOSPHERE, by R. Grant Athay, *Science*, September 16, 1960. "Among the many unanswered questions regarding phenomena of the solar atmosphere, those that stand out are: (i) What is the mechanism of energy supply? (ii) What is the role of magnetic fields? (iii) What is a flare? (iv) What are the instabilities that give rise to spicules and solar activity? (v) What are the nature and variability of solar corpuscular and short-wavelength radiation incident upon the earth as a result of solar activity?"

Amateur Astronomers

A High School Observatory in California

A DREAM of many years has come true for the astronomy club of the Mount Whitney High School here in Visalia, California. In the past, as sponsor of the group, I made my 6-inch homebuilt reflector available for celestial observations, to augment constellation studies and discussions of theory. Now we have an observatory that not only fills our needs but affords an opportunity to introduce astronomy to elementary and junior high school classes, and to the adults of our community as well.

The observatory is a result of special efforts by our senior class last year, some faculty members, and several townspeople. Early in the 1959 school year, under the National Defense Education Act, our federal government agreed to pay half the cost of a 10-inch reflecting telescope. Our school district offered the rest, if we could finance and construct the building. The senior class accepted the challenge.

There were about 20 boys and five teachers on hand when ground was broken the day after Thanksgiving. The crew varied in size from one to 15 students, who worked evenings and weekends to finish the project just before school closed last June. Nearly all technical work and supervision were done by six teachers from the mathematics, chemistry, physics, auto shop, metal shop, and mechanical drawing departments.

A lecture room 20 by 20 feet is attached to the observatory, and both are made from concrete blocks. The floors are of asphalt tile, with acoustical tile on the ceiling. The dome skeleton is of channel iron, and it is covered with plaster lath. Fiberglass was blown onto the outside, and acoustical plaster on the inside. The dome is carried by wheels with four-inch bearings and rides on a circular channel-iron ring.

To earn funds for the building materials, nearly $2,000, the students conducted a fashion show, a Christmas tree sale, and cake sales. But the biggest fund-raising effort was a basketball game between the school coaching staff and members of the San Francisco 49'ers professional football team.

The observatory is located within 50 feet of the science building. Although we must contend with city lights and several trees, we do have a considerable area of dark sky in which to observe.

ARTHUR SHAHZADE
Mount Whitney High School
Visalia, Calif.

JONES BEACH, NEW YORK

"Understanding the Solar System" is the general theme of this season's meetings of the Star Gazers of Jones Beach, New York. Each of these public sessions starts with a brief lecture at Fieldhouse No. 1, and if the skies are clear, is followed by outdoor viewing through 10 manned telescopes. The meetings are on November 6th and 20th, December 4th and 18th, at 7 p.m.

Percy M. Proctor, of Babylon High School, is the lecturer. The get-togethers are cosponsored by the Long Island Park Commission and Abraham and Straus department store.

CLEVELAND OPEN NIGHTS

Warner and Swasey Observatory is continuing its series of public nights during the coming year. On November 3rd and 4th, the topic is "The Sun"; December 1st and 2nd, "Comets, Meteors, and Dust"; February 2nd and 3rd, "Stars and Star Clusters"; March 2nd and 3rd, "Variable Stars"; and April 6th and 7th, "From Atoms to Galaxies."

Lectures begin at 8 p.m., with Thursday nights reserved primarily for adults. Reservations may be made with the observatory, Taylor and Brunswick Rds., E. Cleveland 12, Ohio; phone, Glenville 1-5625.

+++ Amateur Briefs +++

More than 400,000 persons have attended the annual star parties cosponsored by the Cleveland *Press* and the Cleveland Astronomical Society since the first one was held in 1929. Dr. David Dietz, science editor for the Scripps-Howard newspapers, promotes these events. Telescopes are provided by society members.

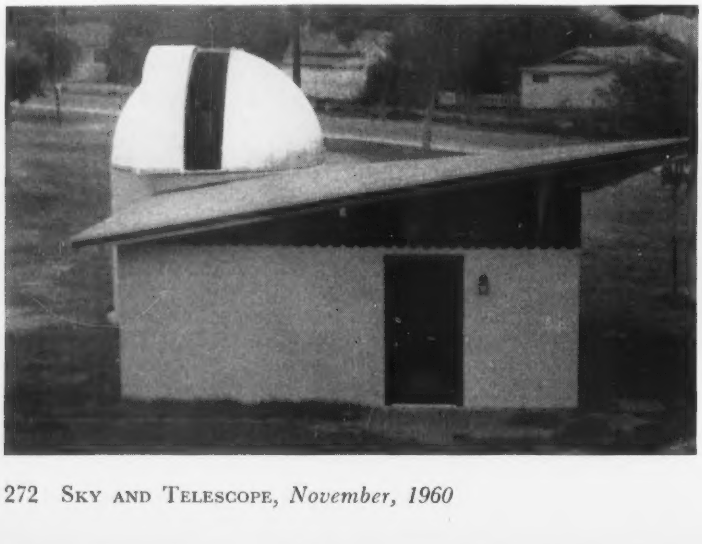
From the bulletin of the Astronomical Society of South Australia: "When is it safe for an ATM to finish his mirror spherical? . . . As a back-garden amateur writing for back-garden amateurs, we would say — stick to spherical mirrors, and make the tube as long as may be convenient. This means that observations made at the zenith should not call for the assistance of a box or a stepladder in order to reach the eyepiece. These wooden aids are uncomfortable to use, and they are a menace in other ways. Keep both feet on the ground with a 6-inch f/10. For short men, f/9. For tall men, f/11. If visitors are to be considered, f/8.2 as per Texereau. If a richest field telescope is contemplated — but that, as Kipling would say, is another story."

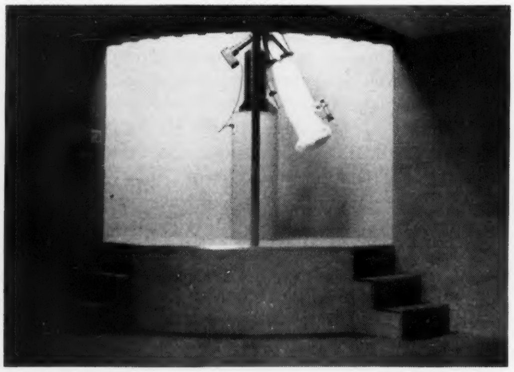
During last summer, J. Russell Smith conducted astronomy classes for 70 students of East Texas State College in Commerce, Texas. His Skyview Observatory in Eagle Pass is always open to amateurs passing through the area.

Each member of the Feather River Astronomy Club in Oroville, California, is required to handle the program at one meeting during the year. The society is currently polishing the mirror for a $10\frac{1}{2}$-inch reflector.

Jim Heinemann, of the Denver, Colorado, Astronomical Society, solved the problem of transporting his 10-inch reflector to a club star party by removing the entire back seat of his car, thereby allowing the telescope tube to extend into the trunk.

Clubs desiring to enliven their meetings may be interested in two sound motion pictures now available for rental





The exterior (left) and interior (above) of the Mount Whitney High School observatory in California. The twin staircase aids group viewing.

from Contemporary Films, 267 W. 25th St., New York 1, N. Y. One, entitled Universe, is a description of a night-long observing session at the David Dunlap Observatory in Canada; the other, The Inquisitive Giant, is a study of the huge radio telescope at Jodrell Bank in England. The rental fees are $7.00 and $7.50, respectively; each film runs for 28 minutes.

Amateurs make newspaper headlines! Arnold Norman, Jr., of Little Rock, Arkansas, had one of his moon photographs on the front page of the *Arkansas Gazette*, and the next day there was an account of his equipment in the *Arkansas Democrat*. Sherman W. Schultz's homemade observatory was the cover story for the Sunday pictorial magazine section of the St. Paul, Minnesota, *Pioneer Press*. Two large pictures of a Kenosha Amateur Astronomers' star party were first-page items of the Kenosha, Wisconsin, *Evening News*.

Travelers passing through Amarillo, Texas, are invited to take in the Friday night observing sessions held by the Panhandle Astronomical Society at Old Soncy School, on U. S. highway 66 west of the city limits.

January 1st is the date by which the Buffalo Astronomical Association hopes to have its observatory in operation. The equipment will include a 7-inch refractor, a 12-inch Newtonian reflector, a remote-controlled all-sky camera, and an adjoining building for offices. The observatory is at the Newstead site of the Cornell Aeronautical Laboratories' ionospheric research center, about a mile east of Clarence, New York.

H. M. C.

NEW ENGLAND AMATEURS MEET IN RHODE ISLAND

About 80 amateurs from all parts of New England were present for the annual astro-assembly sponsored by Skyscrapers, Inc., at their Seagrave Observatory in North Scituate, Rhode Island, on October 1st. Refreshments were served by the hosts in the afternoon, while several astronomical competitions were being judged.

The Amateur Telescope Makers of Boston not only won the prize for largest attendance, but swept the telescope contest with entries by William Sheehan, Ann Sudarich, and Walter Redding. The best astronomical photograph was submitted by the Aldrich Astronomical Society of Worcester, Massachusetts, and an award was given to Arthur Crowe of the host club for his test rig for Maksutov optics.

A steak dinner in the evening preceded an informal series of astronomical ghost stories by Raymond Watts, Jr. Clear skies prevailed for the star party that followed, guests using the Skyscrapers' 8-inch Alvan Clark refractor and other telescopes.

Senior and junior members of the Racine Astronomical Society constructed this colorful float to publicize their club during the July 4th parade held in the Wisconsin city last summer. Photograph by George A. Dechant.

RACINE, WISCONSIN

In order to promote civic interest in its activities, the Racine Astronomical Society entered the float pictured here in the city's annual Fourth of July parade. Both senior and junior members volunteered time and money to build the 7-by-14-foot display. Total cost of the project was under 50 dollars.

The float was planned on a red, white, and blue motif. We fashioned the observatory dome frame from iron wire hoops with struts running to the top, and then covered it with chicken wire. Artificial flowers were made from 7,400 paper napkins, and each was individually stuffed into the frame! Four senior and two junior members rode on the platform, along with three telescopes. The rear wheel hubs of the farm tractor donated to pull the exhibit were covered by a cardboard representation of the earth and an orbiting satellite ball. Our planet did not rotate on its proper axis, but this was intentional, as we wished to have it readily recognized.

The float carried a sign publicizing a star party we held later in the month. Nearly 400 persons attended, despite imperfect observing conditions, and three signed up as new members.

GEORGE A. DECHANT
2225 Shoop St.
Racine, Wis.

CHICAGO ASTRONOMY CLASSES

A series of courses in astronomy, telescope making, and navigation is currently being given at the Adler Planetarium. For information, write the planetarium at 900 E. Achsah Bond Dr., Chicago 5, Ill., or phone Wabash 2-1428.

THIS MONTH'S PROGRAMS

Baltimore, Md.: Baltimore Astronomical Society, 8 p.m., Enoch Pratt Free Library main building. November 21, William P. Gonce, Sr., Martin Co., "Living in Space."

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. November 11, Dr. S. W. McCuskey, Warner and Swasey Observatory, "Satellites and Their Orbits."

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Health and Science Museum. November 28, Ted F. Gangl, "Living with Radiation."

New Orleans, La.: Pontchartrain Astronomy Society, 8 p.m., Tulane University Observatory. November 4, Dr. J. Frazer Thomson, Tulane University Observatory, "The Stars."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. November 2, Dr. Henry Miller, S. J., Fordham University, "Journey to the Center of the Earth — 1960."

New York, N. Y.: Junior Astronomy Club, 8 p.m., Waverly building, New York University. November 18, Dr. Otto Struve, National Radio Astronomy Observatory, "Recent Advances in Astrophysics."

FLORIDA GROUP REORGANIZES

Members of the Choctaw Astronomical Society have reorganized their club, naming it the Northwest Florida Astronomical Association and moving their headquarters to Ft. Walton Beach. The group has 48 seniors and seven juniors. Interested persons are invited to contact J. M. Sherlin, Flamingo Apt. 2, 156 Westview Ave., Valparaiso, Fla.

OBSERVING THE SATELLITES

Discoverer XV

TENTH VEHICLE to achieve orbital velocity in the U. S. Air Force's program to improve satellite technology, Discoverer XV was successfully fired from Vandenberg Air Force Base in California, at 22:13:39 Universal time on September 13th. A later launching time than that for others in the Discoverer series gave fewer daylight hours for the recovery attempt.

The 300-pound capsule was separated on schedule on the 17th revolution, but either orientation of the Agena or thrust from the capsule's retro-rocket went awry, for the re-entry package sailed over the intended recovery zone to a point near Christmas Island in the mid-Pacific Ocean. Less than $3\frac{1}{2}$ hours of daylight remained when radar tracking at Kaena Point, Hawaii, placed the capsule about 1,000 miles from waiting ships and planes. By the time a searching seaplane spotted the floating payload, it was necessary to postpone recovery attempts to the following morning. When operations were resumed, the ocean was too rough to permit a seaplane to land, and the capsule was lost in the turbulent waters within a few hours.

The Agena vehicle remains in orbit as 1960μ. Its initial anomalistic period was 94.19 minutes, with perigee and apogee heights of 126 and 474 miles. The orbital plane is inclined 80.90 degrees to the earth's equator. These values have been derived from information supplied by the National Space Surveillance Control Center (Space Track).

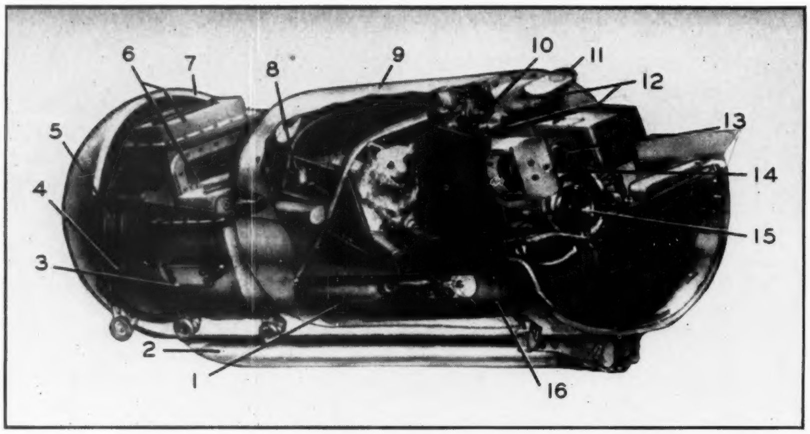
The payload of Discoverer XV was designed to monitor performance during the recovery sequence and to make unspecified measurements of the space environment. Later Discoverers are expected to carry biological specimens.

More About Sputnik V

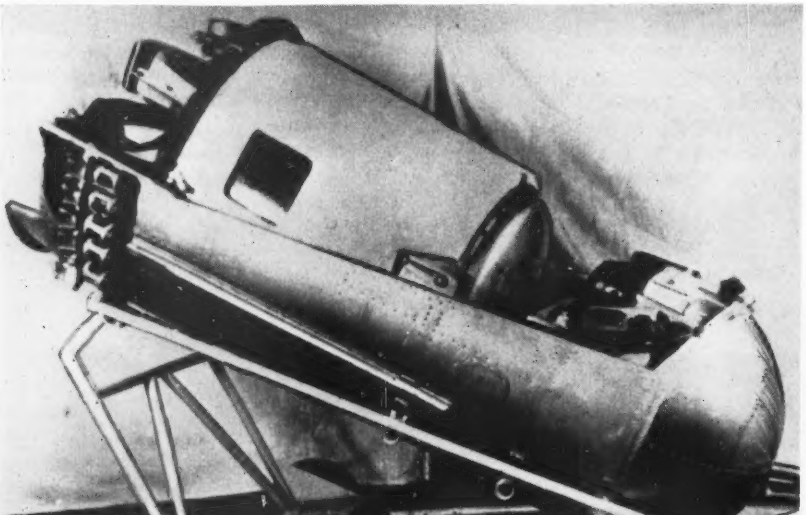
INFORMATION has been received from Soviet scientists about the recovery of the dog-carrying capsule from Sputnik V (October issue, page 201). When the capsule was ejected, $1960\lambda1$ was traveling at only 485 miles per hour, far less than orbital velocity. Thus, the spaceship must have been slowed down prior to the ejection so that the capsule would not suffer the effects of re-entry heating. The final descent to earth was by parachute.

The accompanying photographs show some of the details of the life-support system. The capsule was fully pressurized, with an oxygen content held between 20 and 25 per cent and a carbon-dioxide level below one per cent, according to Soviet accounts. The miniature biological museum was designed to answer several fundamental questions relating to space-environment effects on physiology and subsequent reproductive ability of the specimens.

Chlorella, a seaweed, was carried aloft for a special reason. Sputnik V was described as the first satellite experiment to investigate the use of photosynthesis for removing carbon dioxide and generating oxygen and possibly food during space voyages of long duration.



In this cutaway view of the payload of Sputnik V, the following parts are identified: 1, air-supply tank; 2, ejection firing device; 3, radio beacon; 4, storage battery for heating test tubes containing microbes; 5, storage battery; 6, unspecified instrumentation; 7, container; 8, movement transducer; 9, animals' pressurized capsule; 10, microphone; 11, radio aerial; 12, intake and exhaust valves; 13, television camera; 14, mirror; 15, ventilator; 16, automatic food dispenser. The photographs on this page are courtesy U. S. S. R. Embassy in Washington, D. C.



The recovery capsule of Sputnik V as exhibited by Soviet scientists. The pressurized animal container, here seen nestled in the center of the capsule, is shown from the opposite side in the cutaway view above.

Third Year of the Space Age

THE TABLE opposite provides a listing of all known satellite and space-probe launchings during the past year, and is a continuation of a similar rundown that was presented for the first two years of the space age on page 13 of the November, 1959, issue of Sky and Telescope.

To bring the earlier list up to date, only a few changes are needed: The solar-powered radio in Sputnik III functioned until the satellite ended its orbital career on April 6, 1960; Explorer IV came down on October 23, 1959; radio transmission from Explorer VI ceased on October 6, 1959; that from Vanguard III on December 11, 1959; and Discoverer VI descended on October 20, 1959. The current table begins with the present status of Lunik III.

The new tabulation, together with the earlier one amended above, gives a complete report as of October 4, 1960, for the known launch attempts.

Satellite and Probe Launchings During the Third Year of the Space Age

	Launched		*Site*	*Name and Designation*	*Status*	*Notes*
1959	Oct.	4	S	Lunik III — 1959θ	Down April, 1960	Transmission of moon pictures ended before Oct. 18, 1959. Rocket probably in orbit.
	Oct.	13	C	Explorer VII — 1959ι1	In orbit	Radio operating. Rocket, 1959ι2, also in orbit.
	Nov.	7	V	Discoverer VII — 1959κ	Down Nov. 26, 1959	Fault in power supply prevented capsule recovery.
	Nov.	20	V	Discoverer VIII — 1959λ	Down Mar. 8, 1960	Capsule separated but overshot recovery area.
	Nov.	26	C	Atlas-Able IV (moon orbiter)	No orbit	Shroud protecting payload came off during Atlas thrust.
1960	Feb.	4	V	Discoverer IX	No orbit	Fuel-loading equipment failure damaged vehicle.
	Feb.	19	V	Discoverer X	No orbit	Thor veered off course. Destroyed by safety officer.
	Feb.	26	C	Midas I	No orbit	Second-stage Agena failed to separate from Atlas.
	Mar.	11	C	Pioneer V — 1960α	Solar orbit	311.64-day period. Jodrell Bank held radio contact to 22,462,115 miles. Rocket also in orbit.
	Mar.	23	C	Explorer	No orbit	Telemetry lost shortly after Jupiter burnout; one of the Sergeant-powered stages failed.
	Apr.	1	C	Tiros I — 1960β2	In orbit	Cloud pictures ended June 17, 1960. Tracking transmitter operating. Rocket, 1960β1, in orbit.
	Apr.	13	C	Transit I-B — 1960γ2	In orbit	Radios silent June 19 and July 12, 1960. Able-Star rocket, 1960γ1, and separated object, 1960γ3, also in orbit.
	Apr.	15	V	Discoverer XI — 1960δ	Down Apr. 26, 1960	Capsule separated but was not observed.
	May	13	C	Echo	No orbit	Failure of orientation control during second-stage coasting.
	May	15*	S	Sputnik IV — 1960ε1	In orbit	Radio silent July 2, 1960. Rocket, 1960ε2, down July 17, 1960. Separated parts of spaceship, 1960ε3 through 9, also in orbit; except 7, down Sept. 24, 1960; possibly others down.
	May	24	C	Midas II — 1960ζ1	In orbit	Telemetry of infrared data ended May 26, 1960. Fairing, 1960ζ2, in orbit.
	June	22	C	Transit II-A — 1960η1	In orbit	Radios operating. Separate payload, 1960η2, also functioning. Able-Star rocket, 1960η3, in orbit.
	June	29	V	Discoverer XII	No orbit	Failure of orientation control during second-stage firing.
	Aug.	10	V	Discoverer XIII — 1960θ	In orbit	Capsule recovered Aug. 12, 1960.
	Aug.	12	C	Echo I — 1960ι1	In orbit	Radios operating. Rocket, 1960ι2; two hemispheres, 1960ι3 and 5; and piece of aluminized mylar, 1960ι4, also in orbit.
	Aug.	18	V	Discoverer XIV — 1960κ	Down Sept. 16, 1960	Capsule recovered Aug. 19, 1960.
	Aug.	18	C	Courier I-A	No orbit	First-stage Thor exploded.
	Aug.	19	S	Sputnik V — 1960λ1	Recovered Aug. 20, 1960	Capsule and spaceship recovered. Rocket, 1960λ2, down Sept. 23, 1960.
	Sept.	13	V	Discoverer XV — 1960μ	In orbit	Capsule sighted but lost at sea.
	Sept.	25	C	Pioneer VI (moon orbiter)	No orbit	Second-stage malfunction.
	Oct.	4	C	Courier I-B — 1960ν1	In orbit	Radios operating. Able-Star rocket, 1960ν2, in orbit.

*May have been May 14th UT.

This table is compiled largely from information supplied by the National Aeronautics and Space Administration and by the National Space Surveillance Control Center. Under *Site*, C and V designate American launchings from Cape Canaveral, Florida, and from Vandenberg Air Force Base, California, respectively; S, Soviet launchings from unspecified sites. The U. S. S. R. has not released information on unsuccessful attempts. Dates are in Universal time.

Of these there have been 64 in all, 26 of them in the year under review. The total includes eight announced Soviet firings, three of them in the interval covered by this table.

The United States has fired 56 times toward space during the triennium, achieving 29 successes. These numbers are 23 and 14, respectively, for the year ending October 4, 1960. Thus, just over half of the American tries have been successful, a good performance ratio when the enormous complexity of the missiles is considered.

A typical launching vehicle must perform over a hundred separate automatic functions within close tolerances in order to place an artificial satellite into a chosen orbit. Malfunctioning of such a minor component as a relay or a rate gyro can render the mission abortive.

Of the Soviet launchings, three may be counted as deep-space shots: Lunik I or Mechta, which sailed past the moon to become an artificial planet moving around the sun; Lunik II, which struck the moon (see page 265); and Lunik III, which photographed the moon's far side. Only the last of these shots is within the year under review.

The United States has aimed for deep space eight times in all. Four of the American attempts for the moon failed, two of them in the current year. But two earlier shots returned valuable information from high trajectories, and Pioneer IV passed the moon to continue in orbital motion around the sun.

The lone American success achieved in this category during the third year of the space age was a notable one. Pioneer V was sent into an orbit between those of the earth and Venus, thus becoming the third artificial planet. This probe attained the highest velocity of any launched thus far, and its transmissions could be followed out to the unprecedented distance of 22 million miles.

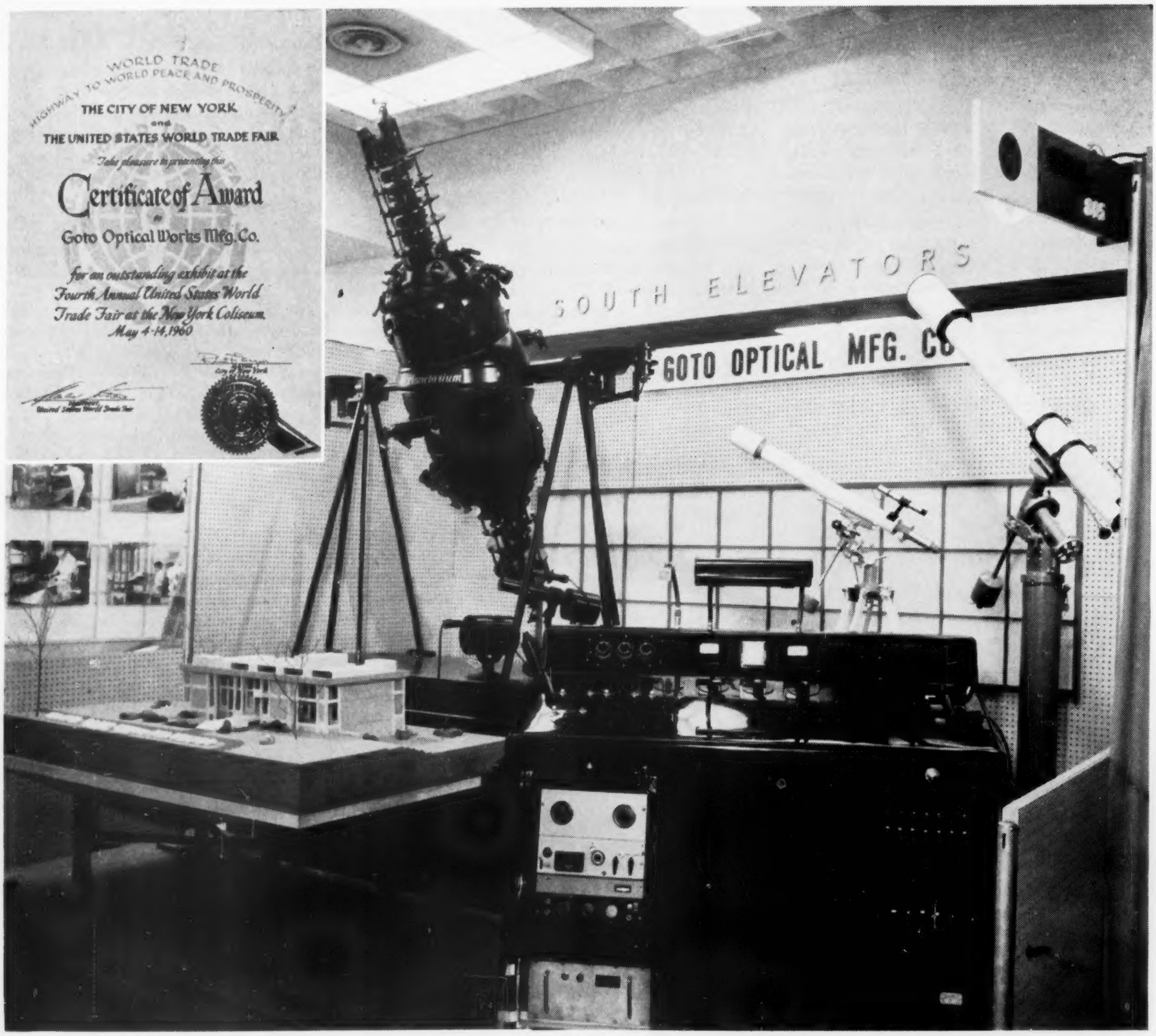
Telemetered data from Pioneer V continue to be analyzed. Already results of great importance are beginning to appear, and will be reviewed later.

Courier I-B

As this issue was going to press, the Advanced Research Projects Agency announced its most recent launching. Courier I-B, sent up from Cape Canaveral on October 4th at 17:50:07 Universal time, is a 51-inch sphere weighing about 475 pounds, with complex equipment for storing and retransmitting radio messages. Known as 1960ν1, it was accompanied into orbit by the second-stage vehicle, 1960ν2.

According to early figures from Space Track, both bodies circle the earth in orbits inclined 28.3 degrees to the equator. For 1960ν1, whose nodal period is 106.9 minutes, the perigee and apogee heights are 587 and 771 miles, respectively.

MARSHALL MELIN
Research Station for Satellite Observation
P. O. Box 4, Cambridge 38, Mass.



GOTO MEDIUM-SIZE PLANETARIUM

The Museum of Art, Science & Industry, Bridgeport, Connecticut is the first institution to install Goto's M-1 medium-size planetarium in its dome. It will open to the public in the fall of this year. The planetarium has won high acclaim when displayed at the 4th annual United States World Trade Fair in May 1960.

GOTO TOKYO

GOTO OPTICAL MFG. CO.

1-115 Shimmachi, Setagaya-ku, Tokyo, Japan
Cable Address: GOTOPTIC TOKYO

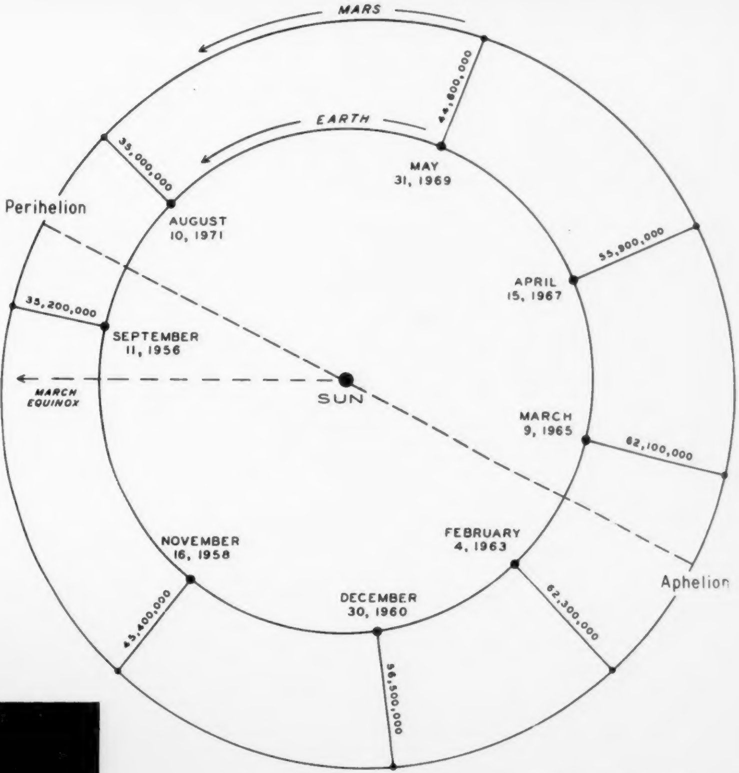
GETTING ACQUAINTED WITH ASTRONOMY

THE PLANETS — MARS – I

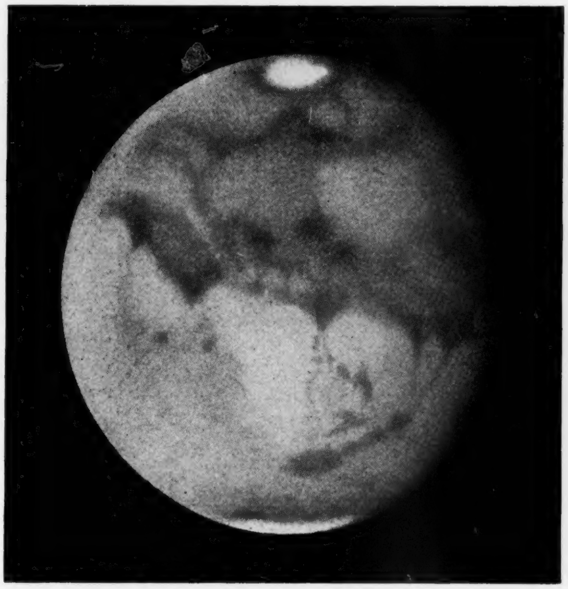
NEARLY all amateur astronomers, whether they are skilled observers or armchair students, will agree that Mars has a fascination shared with no other planet. Among professionals, Mars has been given more attention with large observatory telescopes than Jupiter or Venus.

One reason for this is that Mars is the only celestial body, other than the moon, whose true surface can be studied in detail. Venus, Jupiter, and Saturn are all shrouded in dense atmospheres masking the solid planetary globes, and the only markings seen with certainty are transitory cloud effects. But the thin Martian atmosphere allows us to view a complex pattern of surface features, some of which are recognizable on drawings made three centuries ago. In addition, Mars is the planet whose surface conditions most closely resemble the earth's; of the other bodies in the solar system, it seems the most likely to be an abode of life.

Requiring 687 days to travel once around the sun at an average distance of 141 million miles from it, Mars is a slightly flattened globe with a diameter only 0.53 that of the earth. It rotates once in 24 hours 37 minutes 23 seconds, around an axis that extends to the celestial sphere not far from Alpha Cephei, which is thus the north star for Mars.



Above: Oppositions of Mars from 1956 to 1971 are shown in this chart of its orbit and the earth's. The distances are in miles.



Left: An excellent idea of Mars' appearance in a large telescope under favorable conditions is given by this E. M. Antoniadi drawing, made on November 5, 1909, with the 33-inch refractor of Meudon Observatory. Antoniadi (1870-1944) was one of the greatest of all Mars observers. Greek by birth, he did most of his work in France.

In many respects, the red planet might be called a poor relation of the earth: smaller, less dense, and farther from the sun's light and heat, with a thin atmosphere having very little oxygen or moisture. Perhaps the arid Tibetan plateau is the nearest terrestrial approximation to a Martian landscape.

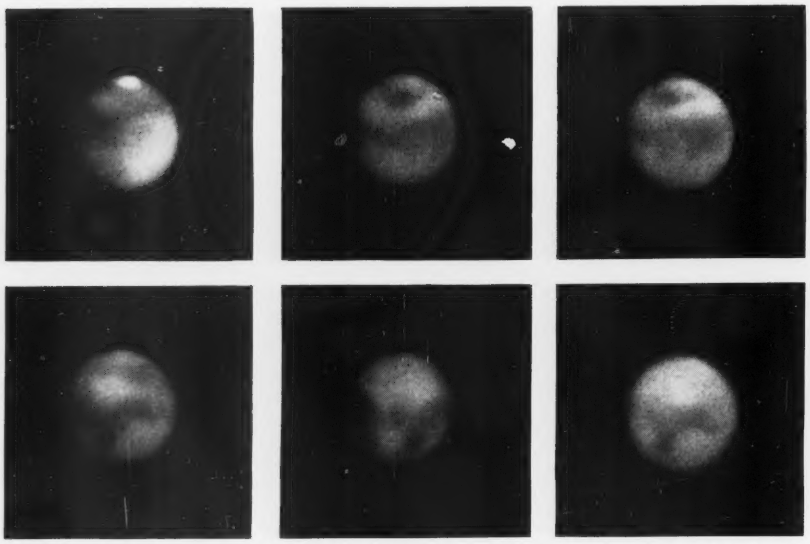
Since Mars takes about 22½ months to complete one revolution around the sun, while the earth in its interior orbit requires 12, our planet overtakes the other at intervals of 26 months. When the earth passes Mars, the latter is said to be in opposition. The last date of opposition was November 16, 1958, when the planet's distance from Earth was 45 million miles. On October 30, 1959, Mars was at superior conjunction, on the far side of the sun, and 240 million miles distant. The next opposition date will be December 30th this year, with the planet 57 million miles away.

These figures help explain why useful observations of Mars are limited to periods of a few months, around the times of opposition. But because of the marked eccentricity of the Martian orbit, not all such occasions are equally favorable. When the planet is at opposition while passing through the perihelion point of its orbit, its distance from us is only 34.5 million miles, but at an aphelion opposition it can be 63 million miles away from the earth.

Especially favorable oppositions occur in a cycle of 15 or 17 years: 1892, 1909, 1924, 1939, and 1956. At such times, the angular diameter of the planet's disk is as great as 25 seconds of arc (about the apparent size of the lunar crater Aristarchus). Such oppositions always occur in August or September, when Mars is well south of the celestial equator. For this reason, perihelion oppositions are best seen from Southern Hemisphere observatories.

The 1960 opposition is relatively unfavorable because of the great distance of the planet, and the maximum apparent diameter of the disk will be only 15.4 seconds. For observers in the United States and Europe, a compensating factor will be the great northerly declination (+27°), so Mars will be high in the sky where telescopic seeing is best.

The minimum distance from Earth will be reached on December 25th, five days earlier than opposition. The cause of this difference is that the motions through space of Mars and the earth in late December are not parallel but slightly divergent. Mars passed perihelion on May



These six photographs of Mars in 1956 were taken by J. H. Botham with the 9-inch refractor of Union Observatory, Johannesburg, South Africa. The south polar cap is conspicuous in the first view, August 25th. In the bottom row, the large dark triangle, near the lowest part of the disk, is Syrtis Major. In the last two exposures, taken two hours apart on September 7th, note how the rotation of the planet has carried Syrtis Major leftward.

26th, and hence its distance from the sun continues to increase.

When Mars is viewed with an adequate telescope under favorable conditions, it presents a small, bright, ocher disk, mottled with darker, greenish shadings, and usually with a brilliant white polar cap. Actually the dark areas are not green, but appear so only by contrast with the bright reddish regions, according to the recent work of G. P. Kuiper.

The first map of the Martian surface that approximates modern standards was drawn by G. V. Schiaparelli, from his observations at Milan during the favorable opposition of 1877. In this map, the Italian astronomer introduced a system of nomenclature still in current use. Dark areas he named after terrestrial seas (for example, Mare Tyrrhenum), bright regions after lands (Hellas), while elongated dark markings – the canals – were called after rivers (Indus). His designations were all drawn from classical geography and mythology.

Many hundreds of names have since been assigned to Martian surface features, real and nonexistent, so the nomenclature has recently been revised by the International Astronomical Union. Since 1958, names have been retained for only about 130 important formations, while lesser features are to be designated by their Martian longitudes and latitudes. The IAU system of nomenclature was presented, with maps, in Sky and Telescope for November, 1958, page 23.

In small telescopes, the Martian maria seem to form a nearly continuous girdle around the southern hemisphere of the planet. But large instruments, under the best seeing conditions, resolve the dark markings into highly intricate tiny mottlings, as is well shown in the maps accompanying H. Camichel's article on page 600 of the September, 1959, issue.

According to Camichel and other expert observers, most canals can be similarly resolved into finer detail, though some seem to be merely boundaries between areas of unlike brightness. In instruments of lower resolving power, canals of both sorts would be seen, if at all, as dark lines. The manner in which an observer depicts detail at the limit of vision depends strongly on how his mind interprets what his eye barely sees.

Because Mars' equator is tipped 25 degrees from its orbital plane, the red planet has seasons analogous to terrestrial ones. In the Martian northern hemisphere, winter set in on July 2, 1960; spring starts on December 8th, and summer begins on June 26, 1961. During this interval, the north polar cap changes markedly in size; largest near the commencement of spring, it will become very small by late Martian summer.

Meanwhile, conspicuous changes occur in the tint of the dark markings. Near the end of winter, a wave of darkening spreads equatorward, crossing it before midspring, and extending into the other hemisphere. This remarkable seasonal variation recurs with much regularity each Martian year. First recognized by Percival Lowell, it has recently been closely studied by G. de Vaucouleurs.

In the planet's southern hemisphere, of course, the seasons are reversed. At the 1960 opposition, Mars' north pole will be slightly tipped toward the earth, and hence the phenomena of the north polar cap will be better visible than those of the south cap.

The amateur who wishes an introductory book about the red planet should read Patrick Moore's *Guide to Mars* (1956). A thorough survey of modern findings is provided by de Vaucouleurs in his *Physics of the Planet Mars* (1954). For detailed topographical information, the standard authority is E. M. Antoniadi, *La Planète Mars* (1930). Among the Sky and Telescope articles on Mars not mentioned above are: June, 1954, pages 251 and 265; July, 1955, page 360; April, 1956, 256; April, 1957, 266; and July, 1959, 484.

(To be continued)

(To be continued)

QUESTIONS... FROM THE S+T MAILBAG

Q. What is the reflectivity of a freshly aluminized mirror in the visible region of the spectrum?

A. For violet light (4000 angstroms) it is 92 per cent, for red (7000) 96 per cent.

Q. What is the *Bonner Durchmusterung?*

A. This is a famous star catalogue, compiled at Bonn Observatory by F. W. Argelander and his associates a century ago. It lists approximate positions of 324,198 stars brighter than nominal magnitude 9.5 (but actually magnitude 11) and north of declination –2°. It is accompanied by an atlas. The catalogue and charts were later extended to –23° by E. Schönfeld of Bonn. The *Bonner Durchmusterung* (BD) catalogue and atlas remain today standard astronomical reference works, and are still in print.

Q. Who holds the record for number of variable stars discovered?

A. By means of photographs Cuno Hoffmeister, of Sonneberg Observatory in East Germany, has found about 5,000 new variables during the past three decades.

Q. What is the greatest number of comets discovered in a single year?

A. In 1947 a total of 14 comets was found.

Q. What is the north polar distance of a star?

A. Its angular distance from the north celestial pole. Thus, a star with an NPD of 70° has a declination of +20°, and NPD 110° corresponds to –20°. Some older catalogues, in particular the NGC, used this co-ordinate instead of declination.

Q. When will the asteroid Icarus make its next close approach to the earth?

A. In 1968, when it will pass 3.9 million miles from us. Its minimum possible distance is 3.5 million miles – about 15 times as far as the moon.

Q. How bright would the sun appear if seen from the nearest star and from the Andromeda galaxy, M31?

A. It would be a star of magnitude 0 from Alpha Centauri, and about magnitude +29 from M31.

W. E. S.

Planetarium Notes

(Most planetariums give group and special showings by appointment.)

CALIFORNIA

LOS ANGELES
Griffith Observatory and Planetarium
Griffith Park, P. O. Box 27787, Los Feliz Station (27). NO 4-1191. Director, C. H. Cleminshaw.
SCHEDULE: Daily (except Monday), 3 and 8:30 p.m.; also 1:30 and 4:30 p.m. Saturday and Sunday. Zeiss projector.

SAN FRANCISCO
Morrison Planetarium
California Academy of Sciences, Golden Gate Park (18). BA 1-5100. Curator, George W. Bunton.
SCHEDULE: Daily (except Monday and Tuesday), 3:30 and 8:30 p.m.; also 2 p.m. Saturday and Sunday. Tuesday, 3:30 p.m. Academy projector.

SAN JOSE
Rosicrucian Planetarium and Science Museum
Park and Naglee Aves. Director, Rodman R. Clayson.
SCHEDULE: Sunday and Wednesday, 2 and 3:30 p.m. Spitz projector.

SANTA BARBARA
Gladwin Planetarium
Museum of Natural History, 2559 Puesta del Sol Rd. WO 6-6720. Lecturer, C. Adair.
SCHEDULE: 1st and 3rd Monday, 3 p.m.; 2nd and 4th Thursday, 8 p.m. Admission free. Spitz projector.

COLORADO

COLORADO SPRINGS
Academy Planetarium
U. S. Air Force Academy. GR 2-2779. Director, Maj. Richard J. Pfrang.
SCHEDULE: (Closed until December 10th) Wednesday, 8 p.m.; Saturday, 2:30 p.m.; Sunday, 2 and 3:15 p.m. Admission free. Spitz Model B projector.

DENVER
Denver Museum of Natural History Planetarium
City Park. EA 2-1808. Curator, Robert E. Samples.
SCHEDULE: Daily, 3:30 p.m.; also 12:30, 1:30, and 2:30 p.m. Saturday and Sunday. Spitz projector.

CONNECTICUT

MYSTIC SEAPORT
Seaport Planetarium
Marine Historical Association. JE 6-2631. Director, Frederic W. Keator.
SCHEDULE: Daily, 2 and 4 p.m.; also noon Saturday and Sunday. Spitz projector.

STAMFORD
Edgerton Planetarium
Stamford Museum and Nature Center. DA 2-1646. Director, Ernest T. Luhde.
SCHEDULE: Saturday, 11 a.m. and 3:15 p.m.; Sunday, 4 p.m. Spitz projector.

FLORIDA

ST. PETERSBURG
St. Petersburg Junior College Planetarium
St. Petersburg Junior College (10). Director, Elizabeth James.
SCHEDULE: Monday, 7:30 p.m. (except school holidays). Spitz projector.

ILLINOIS

CHICAGO
Adler Planetarium
900 E. Achsah Bond Dr. (5). WA 2-1428. Director, Robert I. Johnson.
SCHEDULE: Monday through Saturday, 11 a.m. and 3 p.m.; also 8 p.m. Tuesday and Friday, 10 a.m. Tuesday through Friday (special school program). Sunday, 2 and 3:30 p.m. Zeiss projector.

INDIANA

EVANSVILLE
Koch Planetarium
Evansville Museum of Arts and Sciences, Sunset Park. HA 5-2406. Curator of education, James Gillihan.
SCHEDULE: Sunday, 2, 3, and 4 p.m. Spitz projector.

INDIANAPOLIS
Holcomb Planetarium
Butler University (7). AT 3-1340. Director, Harry E. Crull.
SCHEDULE: Saturday and Sunday, 4 and 8 p.m. Spitz projector.

IOWA

CHEROKEE
Sanford Museum and Planetarium
117 E. Willow. CA 5-3922. Director, W. D. Frankforter.
SCHEDULE: By appointment daily (except Sunday) during museum hours. Spitz projector.

WATERLOO
Theater of the Stars
Grout Historical Museum, Park Ave. at South St. AD 4-6357. Director, Genevieve Woodbridge.
SCHEDULE: Saturday, 2:30 p.m. Admission free. Spitz projector.

MARYLAND

BALTIMORE
Davis Planetarium
Maryland Academy of Sciences, Enoch Pratt Library Bldg., 400 Cathedral St. (1). MU 5-2370. Director, Paul S. Watson.
SCHEDULE: (Sept.-June) Thursday, 7:15, 7:45, 9 p.m.; Saturday, 2 and 3 p.m. Admission free. Spitz projector.

MASSACHUSETTS

BOSTON
Charles Hayden Planetarium
Museum of Science, Science Park (14). RI 2-1410. Director, John Patterson.
SCHEDULE: Tuesday through Friday, 11 a.m. and 3 p.m.; Friday, 8 p.m.; Saturday, 11 a.m., 2 and 3:30 p.m.; Sunday, 1:30, 2:45, and 4 p.m. Korkosz projector.

SPRINGFIELD
Seymour Planetarium
Museum of Natural History (3). Director, F. D. Korkosz.
SCHEDULE: Tuesday, Thursday, Saturday, and Sunday, 3 p.m.; also 8:30 p.m. Tuesday; 2 p.m. Saturday, special star stories for children. Admission free. Korkosz projector.

MICHIGAN

BLOOMFIELD HILLS
McMath Planetarium
Cranbrook Institute of Science. In charge, James A. Fowler.
SCHEDULE: Wednesday, 4 p.m.; Saturday and Sunday, 2:30 and 3:30 p.m. Spitz projector.

FLINT
Robert T. Longway Planetarium
Flint Junior College, 1310 E. Kearsley St. (3). CE 8-1631. Director, Maurice G. Moore.
SCHEDULE: Tuesday, Thursday, Friday, and Saturday, 8 p.m.; Saturday and Sunday, 2 p.m. Spitz Model B projector.

MINNESOTA

MINNEAPOLIS
Science Museum
Minneapolis Public Library, 300 Nicollet Ave. (1). Planetarium director, Mrs. Maxine B. Haarstick.
SCHEDULE: (Beginning December) Saturday and Sunday, 2, 3, and 4 p.m.; also 10 and 11 a.m. Saturday. Admission free. Spitz Model C projector.

MISSOURI

KANSAS CITY
Kansas City Museum Planetarium
3218 Gladstone Blvd. (23). HU 3-8000. Director, Wilber E. Phillips.
SCHEDULE: Saturday and Sunday, 3 p.m. Spitz projector.

LAQUEY
Tarbell Planetarium
Inca Cave Park. Director, E. D. Tarbell.
SCHEDULE: Daily, 10 a.m.-6 p.m., continuous. Spitz projector.

NEBRASKA

HASTINGS
McDonald Planetarium
Hastings Museum. Supervisor, Lawrence E. Brown.
SCHEDULE: Daily, 4 p.m.; also 2 p.m. Saturday and Sunday. Spitz projector.

NEW JERSEY

NEWARK
Newark Museum Planetarium
49 Washington St. (1). MI 2-0011. Supervisor, Raymond J. Stein.
SCHEDULE: Saturday, Sunday (except 1st Sunday of month), and holidays, 2:30 and 3:30 p.m. Admission free. Spitz projector.

NEW YORK

NEW YORK CITY
American Museum-Hayden Planetarium
81st St. and Central Park West (24). TR 3-1300. Chairman, J. M. Chamberlain.
SCHEDULE: Monday, 2 and 3:30 p.m.; Tuesday through Friday, 2, 3:30, and 8:30 p.m.; Saturday, 11 a.m., 1, 2, 3, 4, 5, and 8:30 p.m.; Sunday and holidays, 1, 2, 3, 4, 5, and 8:30 p.m. Zeiss projector.

NORTH CAROLINA

CHAPEL HILL
Morehead Planetarium
University of North Carolina. Director, A. F. Jenzano.
SCHEDULE: Daily, 8:30 p.m.; also 11 a.m. and 3 p.m. Saturday, 3 and 4 p.m. Sunday. Zeiss projector.

OREGON

PORTLAND
Oregon Museum of Science and Industry
4015 S. W. Canyon Rd. (1). CA 6-4518. Planetarium director, Norman C. Smale.
SCHEDULE: Monday through Thursday, 2:30 p.m.; Saturday, 2 and 3:30 p.m.; Sunday, 2, 3, and 4 p.m. Spitz projector.

PENNSYLVANIA

LANCASTER
North Museum and Planetarium
Franklin and Marshall College. Curator, John W. Price.
SCHEDULE: Tuesday and Thursday, 8 p.m.; Saturday and Sunday, 2 and 3 p.m.; Monday, Wednesday, and Friday, 9:15 and 10:15 a.m. (special school program). Admission free. Spitz projector.

PHILADELPHIA
Fels Planetarium
Franklin Institute, 20th St. at Benjamin Franklin Parkway (3). LO 4-3600. Director, I. M. Levitt.
SCHEDULE: Tuesday through Sunday, 3 p.m.; also Wednesday and Friday, 8 p.m.; Saturday, 11 a.m.; Saturday, Sunday, and holidays, 2 p.m. Zeiss projector.

PITTSBURGH
Buhl Planetarium and Institute of Popular Science
Federal and W. Ohio Sts. (12). FA 1-4300. Program director, Arthur L. Draper.
SCHEDULE: Daily, 2:15 and 8:30 p.m.; also 11:15 a.m. Saturday, 4:15 p.m. Sunday. Zeiss projector.

RHODE ISLAND

PROVIDENCE
Roger Williams Planetarium
Roger Williams Park Museum (5). WI 1-5640. Director, Maribelle Cormack.
SCHEDULE: (Oct.-May) Saturday, 3:30 p.m.; Sunday and holidays, 3 and 4 p.m. Admission free. Spitz projector.

TENNESSEE

CHATTANOOGA
Clarence T. Jones Observatory
University of Chattanooga, Brainerd Rd. MA 2-5733. Astronomer in charge, Karel Hujer.
SCHEDULE: Friday, 8 p.m. Admission free. Jones projector.

MEMPHIS
Memphis Museum
233 Tilton Rd. at Central Ave., Chickasaw Gardens (11). GL 2-4732. Director, Mrs. Ruth C. Bush.
SCHEDULE: Saturday and Sunday, 2 and 2:45 p.m.; also 3:30 p.m. Sunday. Admission free. Spitz projector.

NASHVILLE
Sudekum Planetarium
Children's Museum, 724 2nd Ave. S. (10). CH 2-1858. Director, Jacqueline Avent.
SCHEDULE: Sunday, 2:45, 3:30, and 4:15 p.m. Spitz projector.

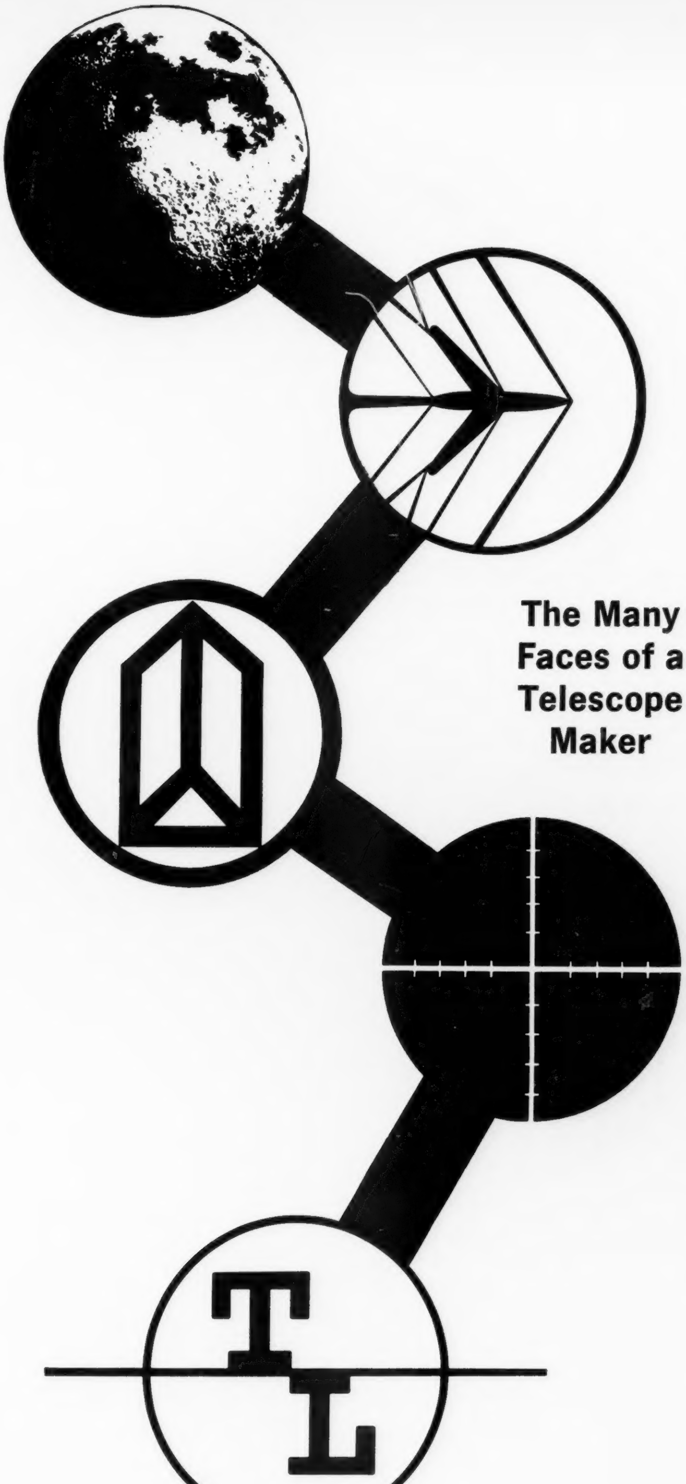
TEXAS

DALLAS
Dallas Planetarium
Dallas Health and Science Museum, Fair Park (10). HA 8-8351. Director, M. L. McDonald.
SCHEDULE: Saturday and Sunday, 3 p.m. Spitz projector.

FT. WORTH
Charlie M. Noble Planetarium
Ft. Worth Children's Museum, 1501 Montgomery. PE 2-1461. Supervisor, Norman C. Cole.
SCHEDULE: Saturday and Sunday, 2:30 and 3:30 p.m.; also 11 a.m. Saturday. Spitz projector.

WEST VIRGINIA

CHARLESTON
Hillis Townsend Planetarium
Children's Museum, Public Library Bldg. Director, Mrs. R. L. Sullivan.
SCHEDULE: Saturday, 11 a.m. Admission free. Spitz projector.



OBSERVER'S PAGE

Universal time (UT) is used unless otherwise noted.

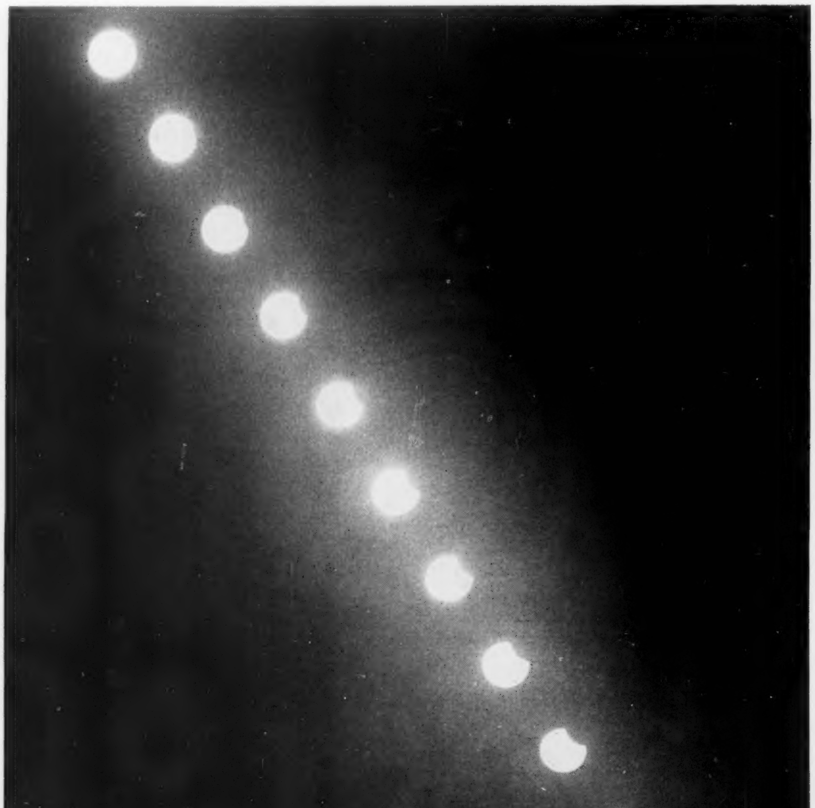
THE SEPTEMBER PARTIAL ECLIPSE OF THE SUN

SEPTEMBER was a banner month for amateur eclipse observers in North America, the moon being totally obscured on the 5th and the sun partly covered September 20th. Not until the year after next will another solar eclipse be visible from the United States — a partial event for Californians at sunset on February 4, 1962, followed by another for Floridians at dawn on July 31, 1962.

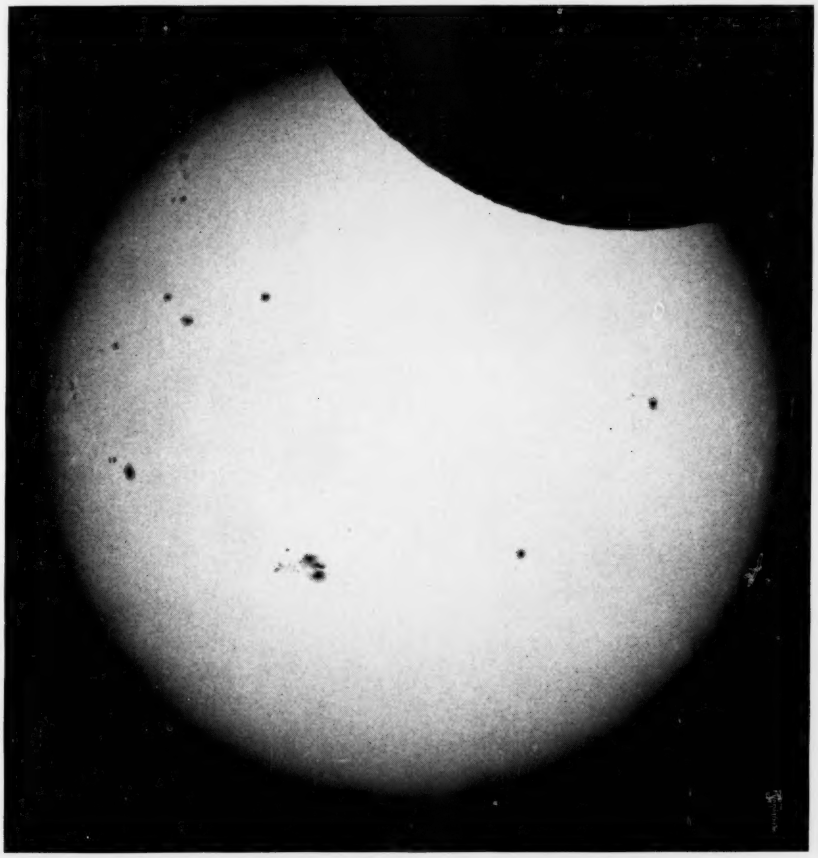
For this year's partial solar eclipse, scattered areas of cloudy weather somewhat hindered the efforts of North American amateurs on the afternoon of September 20th, but those in the southwestern and western states were generally rewarded by a good view. In California and Texas, especially, numerous drawings and photographs were obtained.

In the Middle West, where the eclipse was a late afternoon event, high thin cirrus clouds obscured the view shortly before sunset for amateurs at O'Fallon, Missouri. However, five minutes earlier a good bright projected image was furnished by an 8-inch reflector, the sharp edge of the moon appearing clearly, as well as many sunspots.

Equipment used for pictures that were sent to this magazine ranged from simple



To show the progress of the eclipse at Ft. Worth, Texas, Burton G. Ford made an exposure every five minutes, from 5:30 p.m. Central standard time.

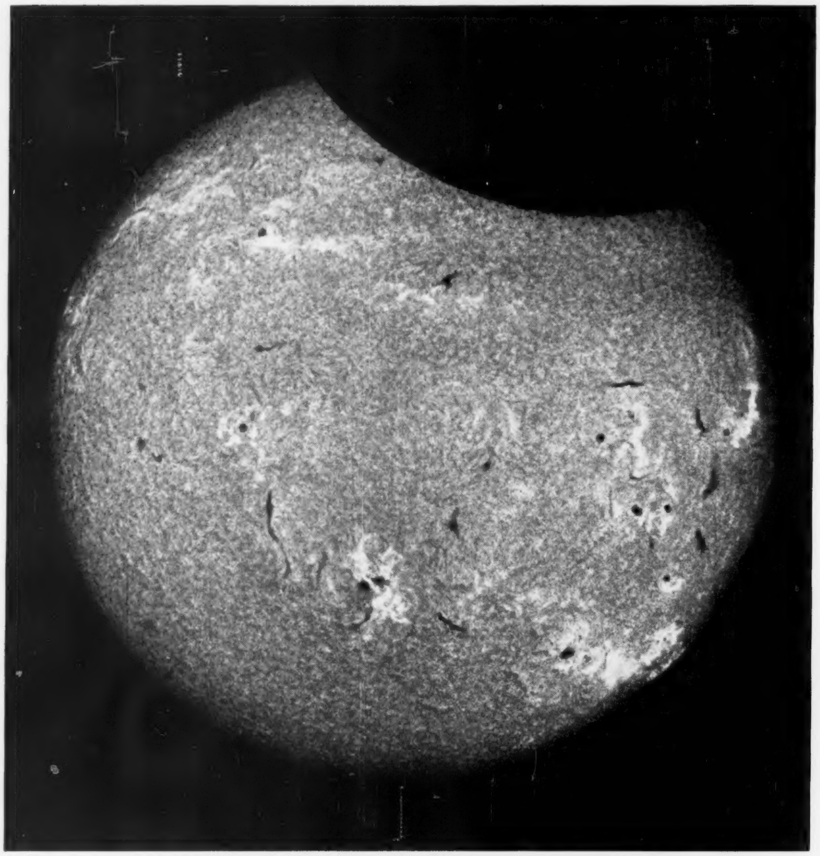


This 1/500-second exposure by Donald E. Lazenby was made at the prime focus of his homemade 10-inch reflector in North Hollywood, California. He reduced the sun's light with a 2½-inch aperture stop and a dense neutral filter. The film was Adox KB-14, developed in X-22. Sunspots, bright faculae, and solar limb darkening are all shown, while the irregularities in the edge of the moon are conspicuous against the disk of the sun.

cameras to the elaborate instruments of the Lockheed solar observatory in Burbank, California. For most places in the United States, the moon obscured between 15 and 25 per cent of the sun's diameter at maximum eclipse. At Ft. Worth, Texas, Burton G. Ford timed the maximum at 6:07 p.m. Central standard time, while Don Lammon, San Bruno, California, noted it as 3:40 p.m. PST, for his location. The latter recorded an obscuration of about 25 per cent.

Two major precautions to dissipate excess light were taken by Jack Eastman, Jr., of Manhattan Beach, California, when photographing the eclipse directly with his 12½-inch reflector. He replaced the aluminized diagonal with an objective

One excellent way to observe a solar eclipse (and the transit of Mercury this month) is being demonstrated by Charles Rothermich to his daughter, Mary, at O'Fallon, Missouri. The solar image is here projected through the eyepiece of an 8-inch Cassegrainian onto a white screen, allowing observation by several people at one time. This method has the advantage that no filters are necessary. Photograph by Robert E. Cox.



This eclipse photograph in red hydrogen-alpha light (turned left-right from the other pictures in this article) was taken through a narrow-band birefringent filter at 4:00:30 p.m., PST, by J. W. Harvey, at the Lockheed solar physics observatory, in Burbank, California.

prism mounted as a Hershel wedge, and then put a No. 11 welder's glass between the wedge and the camera. The wedge passed about four per cent of the incident light, and the filter reduced this by a factor of around 30,000. With this reduction, he could use an exposure time of 1/25 second in direct photography.

Other reports and photographs of the eclipse were received from: John Harvey, Burbank, Calif.; Lewis Chilton, Los Angeles, Calif.; John Shea and Earl Bartsch, Bell, Calif.; Ken Hoover, Long Beach, Calif.; James Williams, Woodland Hills, Calif.; Fred Larsen, Los Angeles, Calif.; D. Colin Wyatt, Victoria, British Columbia; Clyde Honstein, Jr., El Paso, Tex.; William Vance, Kingsville, Tex.; John Marshall, Elmhurst, Ill.; Maurice Moore, Flint, Mich.; Donald Lazenby, North Hollywood, Calif.; Roderick Dunphy, Monta Vista, Calif.; G. Vlahakis, Jr., Salem, Wis.; and David Dunham, Berkeley, Calif.

A camera held at the eyepiece of his 4¼-inch reflector gave Jack Eastman, Manhattan, California, this result.

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Mars on October 13, 1958, as seen through an 8" f/7 De Luxe ASTROLA Reflector. The drawing was made when the Martian longitude of the central meridian was 210°-215°, and the disk was 17.2 seconds of arc in diameter. The power used was 360-450, with seeing fairly good, but transparency only fair.

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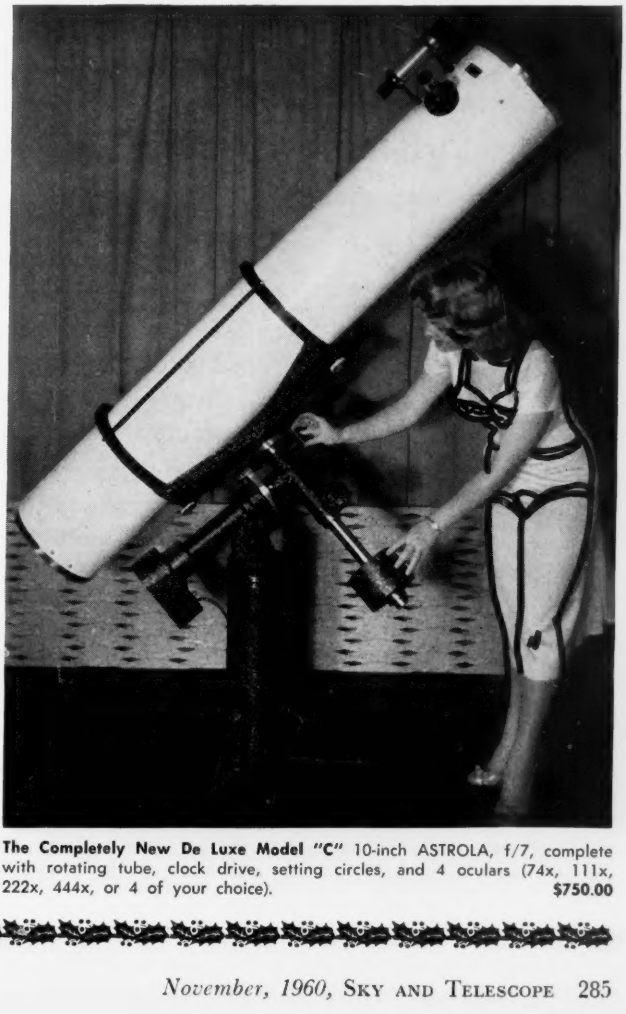

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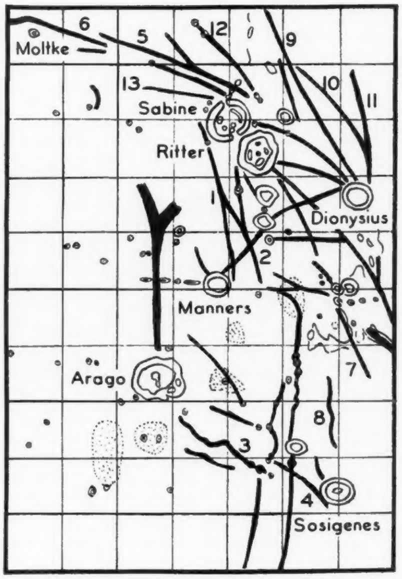
Lunar Rills in Eastern Mare Tranquillitatis

AMATEUR observers of the moon seem to have devoted surprisingly little study to the very extensive system of rills in the eastern part of Mare Tranquillitatis. Perhaps the most important paper devoted to it is that by the French selenographer C. M. Gaudibert (*l'Astronomie, 7,* 182, 1888), although he describes only a little of what is known at the present time. There have been many short notes about parts of the rill system, for example, that by R. Barker in the British periodical, *The Moon* (Vol. 3, No. 1, page 7, 1954). He was, however, concerned only with the southern rills.

Certainly there has not been the attention given to the Mare Tranquillitatis rills that has been given to, say, the famous system just west of the crater Triesnecker.

The accompanying chart summarizes my observations from 1955 to 1960, seven of them with a 7-inch reflector, two with a 12½-inch reflector, and one with the 18-inch refractor of the University of London Observatory. Most of the finer details were found with this last instrument.



This map should be compared with H. P. Wilkins', on page 68 of the 1955 book, *The Moon,* by him and Patrick Moore. Rills **2** and **7-13** are omitted by him. In addition, **3** and **4** are actually not connected, nor are **5** and **6.** On my chart some of the rills are not linear. There is a tendency among observers always to draw rills as regular objects, whereas in fact many of them meander irregularly, for example, **3.** The deviations are usually visible only in large telescopes.

Two other interesting features, believed to be new, are the long, broad, shallow valley that runs southward from Arago, and the row of *elongated* craterlets west of Manners.

I have prepared a chart of the rills near Plato, which is to appear in the *Journal* of the British Astronomical Association, and it shows that many of them are radial to Plato and others to the crater Plato D. Similar examples may be seen in the Mare Tranquillitatis system, where numbers of rills appear to diverge from Ritter and from Dionysius.

Dotted regions on the present map represent domes that I am sure exist. Many small hills and ridges have been omitted for clarity.

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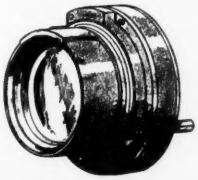

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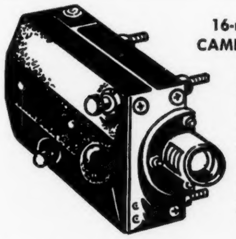

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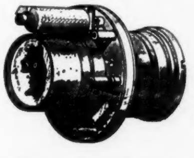

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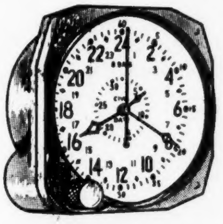

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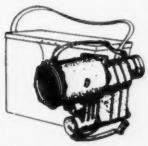

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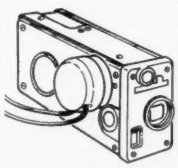

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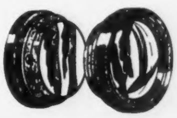

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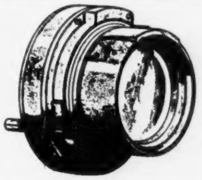

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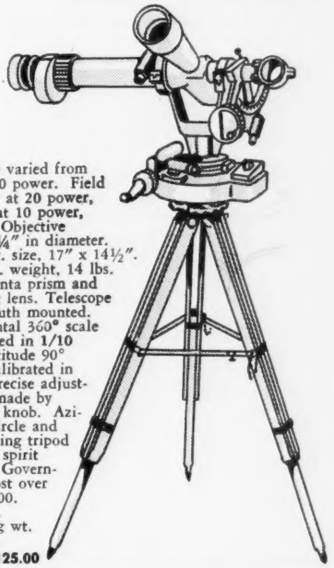

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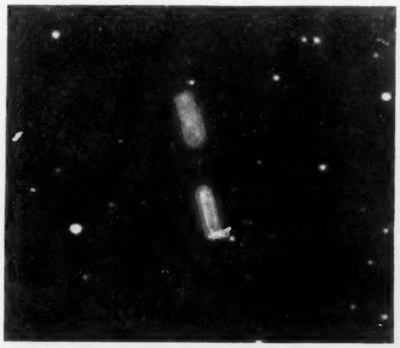
THREE CURRENT COMETS

FOR several years, Los Angeles amateur Alan McClure has used his portable 7-inch f/7 photographic refractor in a program of attempting to rediscover periodic comets on their predicted returns. On the night of September 4-5, 1960, he took this instrument to the summit of 8,828-foot Mt. Pinos, California, in an effort to recover Comet Borrelly, last observed in 1953.

It was a windy but exceptionally clear night, and Mr. McClure waited for the scheduled lunar eclipse to attain totality, giving a sky dark enough for photography. Reproduced below is the 12-minute exposure he obtained, showing the comet as a barely visible 15th-magnitude object. Another picture, exposed for 21 minutes, also revealed it, but was somewhat fogged from twilight.

The identification of the object as the sought-for Comet Borrelly was established by three facts: It was located close to the predicted spot in Leo; it was moving in



Comet Borrelly's very faint image lies between the broad gray marks. Alan McClure took this 12-minute exposure at 11:36 UT, September 5, 1960.

the right direction at approximately the expected rate; a later check revealed no galaxy in the location.

Discovered in 1905, Borrelly's comet has a period of 7.02 years. It passed through the perihelion point of its orbit on June 12th of this year. Hence it is fading steadily as it recedes from both sun and earth.

On the same night, just before he recorded Comet Borrelly, Mr. McClure also took advantage of the eclipse darkness to obtain the 20-minute exposure of Comet Finlay shown here. It is likewise a periodic comet, requiring 6.90 years to complete one orbital revolution. The first observation of its 1960 return was Mr. McClure's photograph of June 20th, but he could not find it on the plate until a later Lowell Observatory position by R. Burnham, Jr., told him where to look.

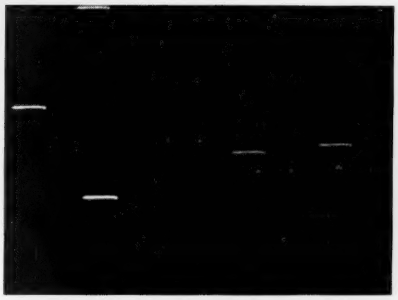
Comet Finlay was considerably brighter than the other. Elizabeth Roemer, at the Flagstaff, Arizona, station of the U. S. Naval Observatory, saw it in a 5-inch finder on September 26th, and estimated

Mr. McClure's September 5th photograph of Finlay's comet shows a coma about 2.7 minutes of arc in diameter.

the total magnitude as about $11\frac{1}{2}$. In November it will be about magnitude 13, and the following predicted positions (1950 co-ordinates) are taken from the *Handbook* of the British Astronomical Association:

November 2, $7^h\ 08^m.0$, $+25°\ 31'$; 12, $7^h\ 06^m.3$, $+26°\ 35'$; 22, $6^h\ 58^m.0$, $+27°\ 41'$. December 2, $6^h\ 44^m.4$, $+28°\ 38'$.

Periodic Comet Encke will return to perihelion on February 5th next year. It was first observed in 1960 on August 18th, by Dr. Roemer with the 40-inch reflector. Then a 19th-magnitude object, the comet was still extremely faint and nearly starlike when she recently obtained the image shown in the picture below.



Periodic Comet Encke is centered in this 30-minute exposure obtained by Elizabeth Roemer on September 26th. Official U. S. Navy photograph.

DEEP-SKY WONDERS

NOT ALL of the Messier objects are grand and impressive. A rather sparse one is M34 (NGC 1039) in Perseus, at right ascension $2^h\ 38^m.8$, declination $+42°\ 34'$ (1950 co-ordinates). It is easily found between Algol and Gamma Andromedae, a little nearer the former.

Unlike most clusters, M34 is not more spectacular in large telescopes, as it does not seem tc 'have the needed fainter stars to buttress the view. Rather, I feel that 15 x 65 binoculars give the best impression, though this is from tests made in the hazy air of the Connecticut River valley. M34 looks much like the Palomar 48-inch Schmidt picture reproduced here – something not quite applicable to most of the clusters we have discussed this year. More magnification merely spreads out the few bright stars that the binoculars show perfectly well.

The open cluster M34, photographed with Palomar Observatory's 48-inch Schmidt camera. South is toward the top in this view, and the width of the picture is one degree. This object is 1,500 light-years away, and it contains 81 stars brighter than magnitude 12.7, according to A. Wallenquist.

H. Shapley lists the cluster's diameter as 18′, although the exact boundaries are not clear, and the count of 80 stars in the catalogues leads the observer to expect more than is to be seen. Nevertheless, the total magnitude of M34 is 6.

As this was my first night of observing in Connecticut, I naturally turned to the objects that I used in Kansas to test the seeing. The Andromeda galaxy M31 did not seem to suffer from poor seeing, for it could be traced out to over three degrees in the binoculars. M33 in Triangulum was out of reach of the naked eye, and in binoculars gave the illusion of hanging between me and the starry background, an effect I have seldom noticed on nebulae. The Double Cluster in Perseus looked washed out and lacked its usual sparkle.

WALTER SCOTT HOUSTON
36 Lawn Ave.
Middletown, Conn.

SUNSPOT NUMBERS

The following American sunspot numbers for July have been derived by Martin Nason, National Bureau of Standards, Boulder, Colorado, from AAVSO Solar Division observations.

July 1, 144; **2**, 152; **3**, 153; **4**, 158; **5**, 141; **6**, 117; **7**, 119; **8**, 117; **9**, 115; **10**, 90; **11**, 72; **12**, 73; **13**, 87; **14**, 91; **15**, 108; **16**, 117; **17**, 118; **18**, 125; **19**, 127; **20**, 126; **21**, 127; **22**, 123; **23**, 106; **24**, 97; **25**, 90; **26**, 82; **27**, 77; **28**, 75; **29**, 82; **30**, 64; **31**, 63. Mean for July, 107.6.

The following American sunspot numbers for August have been derived by Dr. Sarah J. Hill, Whitin Observatory, Wellesley College, from AAVSO Solar Division observations.

August 1, 60; **2**, 34; **3**, 21; **4**, 19; **5**, 17; **6**, 19; **7**, 39; **8**, 41; **9**, 50; **10**, 88; **11**, 167; **12**, 198; **13**, 195; **14**, 237; **15**, 228; **16**, 234; **17**, 243; **18**, 231; **19**, 208; **20**, 126; **21**, 148; **22**, 141; **23**, 96; **24**, 95; **25**, 126; **26**, 133; **27**, 107; **28**, 113; **29**, 97; **30**, 99; **31**, 111. Mean for August, 120.0.

Below are provisional mean relative sunspot numbers for September by Dr. M. Waldmeier, director of Zurich Observatory, from observations there and at its stations in Locarno and Arosa.

September 1, 103; **2**, 105; **3**, 80; **4**, 75; **5**, 83; **6**, 100; **7**, 108; **8**, 107; **9**, 129; **10**, 162; **11**, 149; **12**, 143; **13**, 156; **14**, 157; **15**, 159; **16**, 115; **17**, 114; **18**, 141; **19**, 156; **20**, 171; **21**, 177; **22**, 189; **23**, 168; **24**, 157; **25**, 141; **26**, 114; **27**, 92; **28**, 89; **29**, 74; **30**, 44. Mean for September, 125.3.

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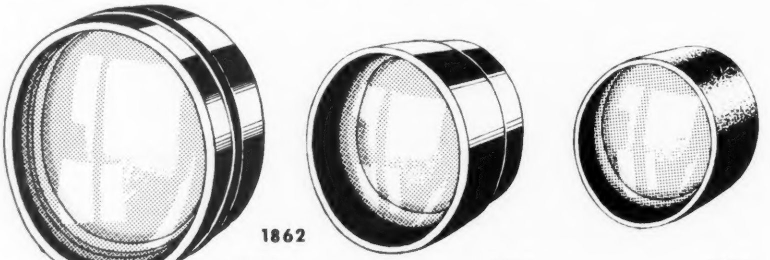

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	Cat. No. S1862	Mounted and Coated	175.00 ppd.

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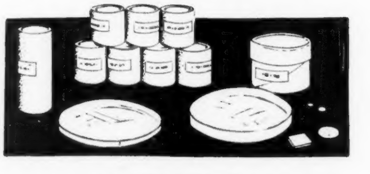

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BOOKS AND THE SKY

ARABISCHE STERNNAMEN IN EUROPA

Paul Kunitzsch. Verlag Otto Harrassowitz, Taunusstr. 5, Wiesbaden, West Germany, 1959. 240 pages. DM 28, paper bound.

THIS great work in German covers such a large field and is so important to the student of star names that a reviewer finds it extremely difficult to determine whether or not he has adequately evaluated the book. Nevertheless, I have had considerable pleasure in reviewing it.

To the title, *Arabic Star Names in Europe,* Paul Kunitzsch might very well have added "and the many corrupt forms thereof." Such forms outnumber the legitimate names many times over. The work is undoubtedly the finest on Arabic star names that has ever been published.

One hundred and fifty years ago the student of stellar nomenclature looked to C. L. Ideler for many of the Arabic names found in the works of T. Hyde and al-Qazwini. But Hyde did not have any authentic manuscripts of as-Sufi; and one could not be sure in some instances what stars were being designated by at-Tizini because of errors in right ascension and declination.

Dr. Kunitzsch's title states that he is concerned with the Arabic star names in Europe. He is, however, too modest, for I believe that he has not restricted himself to any one continent or any one hemisphere. The collection of sources is so thorough that the work could not have been written without the benefit of the great libraries of Europe, Africa, and Asia. And one author who resides in the United States has been mentioned or quoted several times.

The chapter on astrolabes is most excellent and fills a long-felt need. Although we have heard about them in the literature from time to time, there was always much to be desired, and we were never certain that the names were copied correctly.

The history and description of 210 star names, corrupt and otherwise, comprise the most important section of the book. Here, a tremendous amount of information about the Arabic names, including the non-Arabic one Albireo, is given. Unfortunately, in many cases the material is presented in a way that is sure to confuse the reader who is not an accomplished linguist, and who cannot differentiate between the original, most ancient authorities and those authors who may look as important and learned, but whose knowledge of Arabic is not competent. The qualified student, on the other hand, is bound to be most grateful for the many excellent references.

In one important respect Dr. Kunitzsch's work is very disappointing: Without any previous discussion of the possible meanings or interpretations of a given star name he condemns descriptions by other authors as "artificial" or "ridiculous." This procedure reminds one somewhat of the decision of the "Qualifiers" that Galileo's proposition of the immobility of the sun was "foolish and absurd." The reader feels left in a void; with his great knowledge of Arabic, the author should have indicated the reasons for his denunciations or at least given what he believes to be the true definitions and interpretations.

In another respect Dr. Kunitzsch leaves us with a very peculiar sense of the value and meaning of scholarly research. He gives the impression that, unless the exact meaning of a star name is found in an Arabic star text, it is practically sacrilegious for one to attempt to explain it from his own knowledge of Arabic and on the general principles of modern criticism. It is as though it were taboo for scholars such as Sethe, Breasted, or Speleers to write on the monuments of ancient Egypt, or for Kramer, Langdon, or Jastrow to give us the benefit of their great knowledge of Sumerian and Akkadian, or for West, Müller, or Darmesteter to attempt to translate or interpret the difficult passages in Avestan, Pahlavi, and Persian writing.

Dr. Kunitzsch forgets that in connection with all ancient languages covering

long periods of time, certain significant bits of knowledge become lost. Even the meaning of the Sphinx had been forgotten or misunderstood by the time of the Empire or New Kingdom of Egypt. The author, I must admit, has a right to be skeptical at times concerning the knowledge of some moderns who feel the urge to write on star names; only a few years ago a well-known observatory published under its own aegis a list of Arabic star names with their meanings. In this list one of the names of Alpha Hydrae was translated as "The Brave Man's Neck." Such stellar erudition is hardly to be appreciated.

The beautiful modern Oriental system of transliteration has been used throughout, and the author and his publisher are to be congratulated on this score, as I have not yet found any typographical errors. It is unfortunate, however, that a book so important does not have a more durable and attractive binding.

The student of star names has waited for this book for many years; and from now on there will be no excuse, including even ignorance of Arabic, for writers on the constellations to make the same mistakes generation after generation.

GEORGE A. DAVIS, JR.
Buffalo, N. Y.

THE SEARCH FOR ORDER

Cecil J. Schneer. Harper and Bros., New York, 1960. 398 pages. $6.00.

THE AUTHOR of this book, a comparatively young geologist-crystallographer, must be considered a rather remarkable scholar. In an age when specialization makes conversational strangers even of fellow faculty members in one department of a college, he can write lucidly and entertainingly about every field of science from botany through relativity. Dr. Schneer is a well-nigh perfect example of what he would like to have every serious science student become before he undertakes the ever-narrowing journey to proficiency in his chosen specialty.

As stated in the preface, "there can be a sense of excitement and compulsion to science," and the author has pretty well conveyed this to the reader. But the apology for the historical order of his development is not as well expressed as the one of Dr. Henry Margenau in the book's foreword: "It is commonly supposed that discussion of method makes the teaching of science more difficult. I doubt if this is true, but if it is, a compensating emphasis will make it easy. This is the accent on *history* of science . . . for it exposes the existential bond which holds scientific thought together. Historical incidents furthermore enliven the teaching of science in an anecdotal way, and liveliness is surely needed in our elementary science courses."

Dr. Schneer's classes, the reviewer believes, must be quite lively with anecdotal material, much of which he has included in the book. Sometimes this leads to a slight looseness in expression of the scientific principles involved, but that is usually well taken care of later on. In a way, the author does not let either the personal anecdote or the critical scientific point stand in the way of his objective – to point up the search for order. He confesses what so many of us fail to realize, that we cannot define the scientific method in so many words or even in so many volumes, but we can, by a critical and thorough review of the march of science, have a certain sure feeling for it.

The young scientist is likely to find the chapter on "Classical and Nonclassical Science" very revealing and even, in spots, rather startling. The scientist who is three decades or more beyond his own student days will similarly be disturbed by having science and truth, science and history, and science and so many other catchwords of our civilization, so keenly discussed in a way that many teachers should envy.

Dr. Schneer often plays the role of the die-hard antagonist very well, never scoffing at an outmoded way of thinking except when it has rested upon poor foundations. He has been very gentle with the obstructionists, defending them for their sincerity and thus attempting to pass along to us a lesson that all of

us may, at some time or other, find hard to learn.

There are remarkably few outright errors in the book: Pluto's date of discovery is given as 1934 on page 123, the sun's distance from the center of the galaxy as 50,000 light-years on page 162; Galileo heard reports of sunspots on page 59 and discovered companions to Saturn (with no further explanation) on page 60; and there are a small handful of other mistakes. But they certainly do not detract from the fine quality of the writing and the clearness of expression in the book taken as a whole. The choice of illustrations is good, and the mechanical aspects of the volume are conducive to reading large sections at one sitting.

The reasoning is rather rigid in many passages, requiring considerable concentration and even, on occasion, a fast reprise of an earlier section for full comprehension, but the end result is rewarding. The reviewer wonders how well the average student of the liberal arts could follow some of the exposition with the one casual reading he would presumably want to give it.

Certainly this is not to be considered a "popular" book in the usual sense, but few really good works are popular. For the serious student of science, this volume should be required reading. For the serious citizen who wishes to find out what is happening to his comfortable early 20th-century world, this book contains many of the answers. At the conclusion of almost every chapter, Dr. Schneer's paragraphs, not of summary but of impression and impact, in themselves could stand among the most quotable expressions of social consciousness of our times.

A beautiful blend of science, philosophy, and humanism has been achieved in this book. As a reference volume for a lively series of lectures to beginning students in liberal arts colleges, Dr. Schneer's method could project that "sense of excitement and compulsion" that would persuade more young people to embark on careers of science.

ROY K. MARSHALL
New York, N. Y.

PHYSICS AND MEDICINE OF THE ATMOSPHERE AND SPACE

Otis O. Benson, Jr., and **Hubertus Strughold,** editors. John Wiley and Sons, Inc., New York, 1960. 645 pages. $12.50.

THE PROCEEDINGS of the second international symposium on physics and medicine of the atmosphere and space, held in San Antonio, Texas, in November, 1958, are reported in this volume, making it a must for everyone concerned professionally with the problems of space. Furthermore, it provides the nonspecialist with authoritative and comprehensible information.

The editors are pioneers in space medicine who arranged the first symposium on the topic in 1952. The balanced format and wide scope of this book are derived from their experience.

At the May, 1958, IGY symposium on the use of satellites for biological research, there were difficulties in the semantics of communication between physicists and biologists. However, a remarkable improvement in mutual comprehension is demonstrated in the present volume, which contains 44 papers presented by internationally known scientists.

Eight of these reports deal with the physical composition of the upper atmosphere and the contents of interplanetary space. H. K. Kallman of the Rand Corp. reports that rocket and satellite data disclose higher densities in the upper atmosphere than had previously been assumed. Large day and nighttime variations in atmospheric density occur, as well as changes with latitude. F. L. Whipple assesses the amount of meteoric material in space, and the hazards of meteoric impact in space vehicles and operations.

J. A. Van Allen discusses how the radiation belts that bear his name may influence spaceflight. The theory that the earth's magnetic field is trapping and storing solar corpuscular radiation is explored by S. F. Singer in his discussion of interplanetary dust and radiation.

M. Nicolet, University of Brussels, gives

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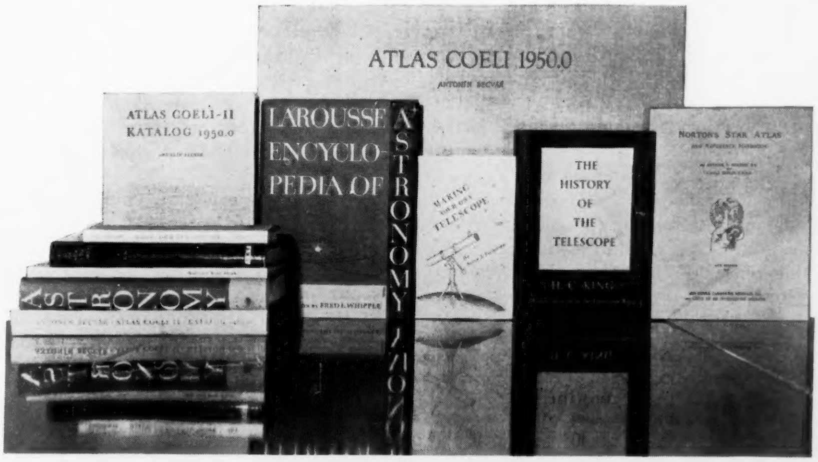

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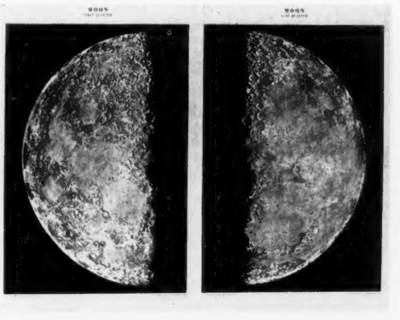

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an extended presentation of atmospheric chemical reactions. Oxygen and nitrogen, the principal gases of the atmosphere, are affected by solar radiation, which causes great variability of composition at higher levels.

Among the seven articles on technical phases of space travel is W. von Braun's discussion of timing in satellite launchings. Firing without careful prelaunching study might place a satellite in continuous sunlight, where its internal temperature could rise so high as to injure the apparatus and affect the success of the mission.

Sixteen papers presented next examine biological aspects of spaceflight. H. G. Clamann reports the physiological effects of ozone, especially in connection with high-flying aircraft and balloons. At 100,000 feet, concentrations of this gas reach four to six parts per million (p.p.m.).

Exposure to the inhalation of two p.p.m. of ozone for 16 hours a day depressed the growth rate of rats. Irritable behavior is manifested by human subjects in a concentration of only one p.p.m. Exposure to six p.p.m. for an hour led to a marked decrease in the vital capacity of one subject, whose lung alveoli became partially filled with fluid.

Dr. Clamann also reviews some metabolic problems of a sealed cabin environment: oxygen requirements and processes of carbon dioxide elimination. Although rapid developments have taken place in this field since 1958, the article is still pertinent. J. Meyers, pioneer in algae physiology and related photosynthesis, presents the use of algae for gas exchange in a closed ecological system of the sealed space-cabin type.

Psychological problems of spaceflight indicated by laboratory experiments with sensory deprivation are well covered by G. T. Hauty. The foremost authorities on weightlessness, S. J. Gerathewohl and J. E. Ward, give an excellent account of its effects as simulated in parabolic flights. They consider spatial orientation, neuromuscular control, and other physiological functions.

Problems of visual perception, accommodation, and reaction time under spaceflight conditions are described by H. Rose. Vision in the higher atmosphere and in space differs from that at sea level. Because of the gradual decline of light-scattering air particles, the sky becomes darker with increasing altitude and stars are visible by day. Outside the atmosphere light intensities are increased about 40 per cent.

Rescue operations from space vehicles are the topics of six papers, and the volume is concluded with a six-paper discussion of the physics and environment of the sun and planets.

This book seems to be the most important treatise on space biology thus far published in any language.

HOWARD LASKEY, M.D.
Carolina, R. I.

NEW BOOKS RECEIVED

THE UNIVERSE AROUND US, *Sir James Jeans*, 1960, *Cambridge University Press*. 297 pages. $1.95, paper bound.

First published in 1929, this classic by an outstanding British astronomer has been reissued as a reprint of the fourth (1944) edition. The nature and origin of the stars and galaxies are lucidly described for the informed general reader. Much of the discussion of evolutionary problems, however, has been outmoded by recent work.

THE PLANETARY EQUATORIUM, *E. S. Kennedy*, translator, 1960, *Princeton University Press*. 267 pages. $7.50.

The facsimile reproduction of a Persian astronomical manuscript, together with a line-for-line translation and an extended commentary, make up this volume. The text is largely devoted to a description of an astronomical computing device invented in the 15th century by Kashi, who worked at Ulugh Beg's observatory in Samarkand. The device was used to predict solar, lunar, and planetary positions, and the details of eclipses.

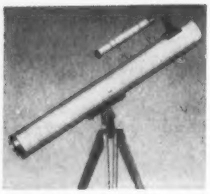
APPARENT PLACES OF FUNDAMENTAL STARS — 1961, 1960, *Astronomisches Rechen-Institut*, Mönchhofstr. 12-14, Heidelberg, West Germany. 511 pages.

The 21st of a series, this annual volume is prepared under the auspices of the International Astronomical Union. It lists apparent positions of 1,535 bright stars, giving right ascensions to 0.001 second and declinations to 0".01, at 10-day intervals.

In the United States, order from Cincinnati Observatory, Cincinnati 8, Ohio. Advance payment of $6.50 per copy is required (covering postage and packaging); make checks payable to Cincinnati Observatory APFS. European orders should be sent to Verlag G. Braun, Karl Friedrich Str. 14, Karlsruhe, West Germany.

AN INTRODUCTORY TREATISE ON THE LUNAR THEORY, *Ernest W. Brown*, 1960, *Dover*. 292 pages. $2.00, paper bound.

Although first published in 1896, this remains the standard English-language text on the moon's orbital motion. Written by a master of celestial mechanics, it traces the methods of Laplace, de Pontécoulant, Hansen, Delaunay, and the author. The highly technical treatment is intended for readers with an extensive mathematical background.



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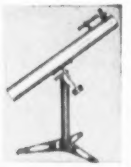

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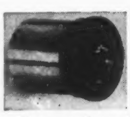

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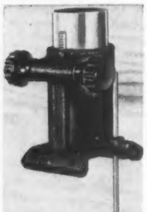

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For Refractors

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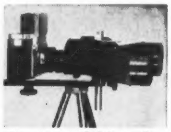
BINOCULAR-TO-CAMERA HOLDER

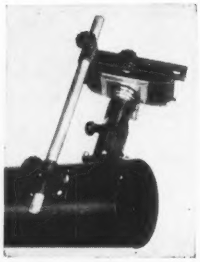
For Exciting Telephoto Shots
Will fit any camera



Bring distant objects 7 times nearer with a 35-mm. camera, 7 x 50 binocular, and our BINOCULAR-TO-CAMERA HOLDER. Ideal for photographing the constellations, star clusters, the moon, as well as cloud formations, wildlife, vistas. Camera and binocular attach easily. Use any binocular or monocular — any camera, still or movie. Take color or black-and-white. Attractive gray crinkle and bright chrome finish, 10" long. Full directions for making telephoto pictures included.

Stock #70,223-Y .... **$11.50 ppd.**

Take Pictures Through Your Telescope with the EDMUND CAMERA HOLDER for TELESCOPES



Bracket attaches permanently to your reflecting or refracting telescope. Removable rod with adjustable bracket holds your camera over scope's eyepiece and you're ready to take exciting pictures of the moon. You can also take terrestrial telephoto shots of distant objects. Opens up new fields of picture taking!

SUN PROJECTION SCREEN INCLUDED

White metal screen is easily attached to holder and placed behind eyepiece. Point scope at sun, move screen to focus . . . and you can see sunspots!

All for the low, low price of $9.95

Includes brackets, 28¾" rod, projection screen, screws, and directions. Aluminum; brackets black crinkle painted.

Stock #70,162-Y .... **$9.95 ppd.**

PRISM STAR DIAGONAL

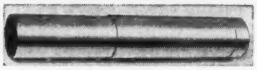
For comfortable viewing of the stars near the zenith or high overhead with refracting telescopes using standard-size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent high-quality aluminized right-angle prism. The tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

Stock #70,077-Y .... **$12.00 ppd.**

AMICI-PRISM STAR DIAGONAL

Same as above except contains Amici roof prism instead of usual right-angle prism. Thus your image is correct as to top-bottom, making it excellent for terrestrial viewing.

Stock #50,247-Y .... **$12.00 ppd.**



NOW! LENS ERECTOR FOR TERRESTRIAL VIEWING WITH YOUR REFLECTOR

This Edmund development adds real convenience to viewing objects on the earth. Just put the lens erector in your eyepiece holder, insert eyepiece, and focus normally. You see everything right side up and correct as to left and right. Made of polished chrome-finish brass telescoping tubing that will fit any standard 1¼" eyepiece holder. Tubing is 9½" long and slides 3" into eyepiece holder. Erecting system consists of two coated achromats.

Stock #50,276-Y .... **$9.95 ppd.**

GIANT-SIZE FULL-COLOR ASTRONOMICAL POSTCARDS

Ideal for Mailing to Your Amateur Friends . . .
For Framing as Room Decorations

You'll be thrilled when you see these new astronomical postcards by Edmund. They consist of dramatic full-color renderings of Mars, Jupiter, Saturn, a sunspot, and a solar prominence, all done by astronomical artist Hugh Stevenson. Size, 5½" x 7".

Stock #40,398-Y .... Set of 5 .... **50c ppd.**

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes; polished and aluminized, lenses for eyepieces, and diagonal. No metal parts.

Stock #50,074-Y .... **$16.25 ppd.**

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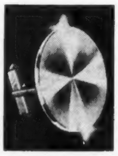

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A Dazzling Rainbow of Color!

Shimmering rainbows of gemlike color in jewelry of exquisite beauty — made with CIRCULAR DIFFRACTION-GRATING REPLICA. Just as a prism breaks up light into its full range of individual colors, so does the diffraction grating. Promises to become a rage in current fashion.

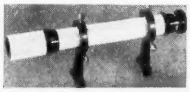
Stock #30,349-Y	Earrings	**$2.75 ppd.**
Stock #30,350-Y	Cuff Links	**$2.75 ppd.**
Stock #30,372-Y	Pendant	**$2.75 ppd.**
Stock #30,390-Y	Tie Clasp	**$2.75 ppd.**

WAR-SURPLUS TELESCOPE EYEPIECE

Mounted Kellner eyepiece, type 3. Two achromats, focal length 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y .... **$7.95 ppd.**

6X FINDER TELESCOPE



Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 2 holders each with 3 centering screws for aligning with main telescope. 20-mm.-diameter objective. Weighs less than ½ pound.

Stock #50,121-Y .... **$8.00 ppd.**

STANDARD 1¼" EYEPIECE HOLDER

Here is an economical plastic slide-focus eyepiece holder for 1¼" O.D. eyepieces. Unit includes 3"-long chrome-plated tube into which your eyepiece fits for focusing. Diagonal holder in illustration is extra and is not included.

Stock #60,067-Y .... **$2.50 ppd.**
Stock #60,049-Y Diagonal holder .... **$1.00 ppd.**

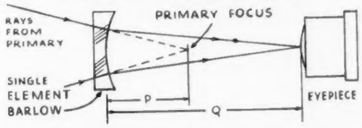
EDMUND SCIENTIFIC CO.

THE ORIGINAL GOODWIN RESOLVING POWER BARLOW

For many years, this achromatic coated Barlow lens has been the pride and joy of serious astronomers. Due to the death of the designer, Mr. Frank Goodwin, it has not been available for the past two years. NOW, we can offer these lenses, in exact accordance with the original specifications. Remember, this Barlow is achromatic, coated, mounted in a blackened tube, and as optically perfect as only precision craftsmen can make it. Complete with instructions, in a 4"-long adapter tube for standard 1¼" eyepieces.

Stock #60,122-Y .... **$23.50 ppd.**

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q.

Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing, with special spacer rings that enable you easily to vary the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Barlow lens is nonachromatic.

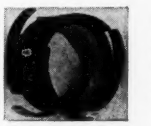
Stock #30,200-Y ... Mounted Barlow lens .... **$8.00 ppd.**

UNMOUNTED 3X BARLOW LENS

These lenses are made for telescopes that have smaller-diameter eyepieces than the standard 1¼" size. Mount one between the eyepiece and objective, and triple your power. Instructions included. Single-element lens, focal length −1-5/16", unmounted.

Stock #30,185-Y .... 0.932" diam. .... **$3.50 ppd.**
Stock #30,328-Y .... 0.912" diam. .... **$2.50 ppd.**

3X ADJUSTABLE-DIAMETER BARLOW LENS



For telescopes with eyepieces smaller than the standard 1¼" outer-diameter size. Prongs on mount can be opened or closed to fit tubes from 13/16" to 1" outer diameter. Directions for using included.

Stock #30,339-Y ...... **$5.00 ppd.**

MORE POWER FROM YOUR JAPANESE TELESCOPE

Mounted Barlow for Japanese Telescopes

By inserting this single-element lens in the eyepiece end of your Japanese telescope, and putting your regular eyepiece in the end of the Barlow tube, you can increase your telescope's power up to three times. Thus, instead of 60x, you will get 120x or 180x. Barlow is mounted in two pieces of telescoping brass tubing each 4" long, satin chrome plated on the outside. Inner diameter of large tube and outer diameter of small tube are 0.965", the standard size for most Japanese telescopes. Measure yours before ordering. 0.965" is approximately 31/32" or 24.5 mm.

Stock #30,370-Y .... **$6.00 ppd.**

SPECIAL! VARIABLE 10- TO 20-POWER U. S. ARMY OBSERVATION TELESCOPE

This is the most versatile and complete government - surplus telescope unit we have ever offered you. USES: spotting scope, surveying, balloon and satellite tracking, all general observation. *THE TELESCOPE:* Elbow-type, 10 to 20 power continuously variable. Field of view 6° 9' to 3° 5'. 2¼" objective lens. Focusing eyepiece. *THE MOUNTING:* This is really something! Has completely enclosed 8"-diam. circle scale reading directly to 1/10 mil or approx. 20 seconds. (6400 mils equal 360°.) Clutch release allows rapid rotation. Rotates 90° horizontal to vertical with direct reading to 1 mil. Has crossed levels, precision adjustment, and many other exciting features. *THE TRIPOD:* Made of solid oak with brass fittings. Has cast brass head with four leveling screws. Legs adjustable from 30" to 52" excluding mount height. Extremely sturdy and rigidly cross braced. Instruments used but in good condition. Shipping wt. approx. 100 lbs.

Stock #85,117-Y .... **$89.50** f.o.b. Chicago

CLOCK-DRIVEN EQUATORIAL MOUNT ON PEDESTAL BASE IDEAL FOR YOUR 6" OR 8" REFLECTOR

Accurate electric clock drive and heavy-duty mounting. Operates on household current. Follows stars smoothly. Pedestal is 24" high. Polar-axis shaft diameter 1".

Stock #85,111-Y .... **$74.50** f.o.b. Barrington, N. J.

Same mount and clock drive on 32" hardwood tripod.

Stock #85,081-Y .... **$69.00** f.o.b. Barrington, N. J.

Same mount on metal pedestal, no clock drive.

Stock #85,108-Y .... **$45.00** f.o.b. Barrington, N. J.

Same mount on tripod, no clock drive.

Stock #85,023-Y .... **$39.50** f.o.b. Barrington, N. J.

STARS THAT GLOW IN THE DARK

Transform your den or bedroom into a realistic night sky. Schools, too, can set up authentic sky scenes showing constellations, planets in a dark room for daytime lectures or explanations of earth and space science. Equally attractive as a means of making your children's room a fairyland, where their canopy of stars will make them welcome rather than fight "lights out." Set consists of 125 luminous star decals made of a safe, nonradioactive phosphor. Stars glow after exposure to strong light.

Stock #9298-Y .... **$1.00 ppd.**

Mounted Ramsden Eyepieces

Standard 1¼" Diameter

Our economy model, standard-size (1¼" O.D.) eyepiece. We mounted two excellent quality plano-convex lenses in black anodized aluminum barrels instead of chrome-plated brass to save you money. The clear image you get with these will surprise you. Directions for using short focal length eyepieces are included with both the ¼" and ½" models.

Stock #30,204-Y ..... ¼" focal length ..... **$4.75 ppd.**
Stock #30,203-Y ..... ½" focal length ..... **$4.50 ppd.**

STAR AND SPACE MAPS

Three giant maps: 1. THE SOLAR SYSTEM, 50" x 38", showing planet statistics; detailed moon map; 12 telephoto pictures of moon, sun, planets. 2. WORLD STAR CHART, 50" x 38"; locates stars for any time of year, any position on earth. 3. MAP OF THE SOLAR SYSTEM, 35" x 48"; shows planets, zodiac, and so on.

Stock #9245-Y .... Set of 3 maps .... **$1.25 ppd.**

8" SETTING-CIRCLE SET

Stock #50,133-Y .. Complete set .... **$3.00 ppd.**
Stock #60,078-Y .. 360° declination circle only **$1.60 ppd.**
Stock #60,079-Y .. 24-hour right-ascension circle only **$1.60 ppd.**

5¾" SETTING-CIRCLE SET

Stock #50,190-Y .. Complete set .... **$2.50 ppd.**
Stock #60,080-Y .. 360° declination circle only **$1.35 ppd.**
Stock #60,081-Y .. 24-hour right-ascension circle only **$1.35 ppd.**

LARGE ERFLE EYEPIECE 1½" F.L.

War-Surplus Bargain — Gov't. Cost Approx. $100

Large telescopes should have one of these for low-power viewing. Apparent field of view 65°. Also use with the 24"-focal-length Aerial Camera lens to make a 16-power wide-field telescope or a 27-power scope with one of the 40"-focal-length Aerial Camera lenses. Low-reflection-coated, 5-element lens system. Field lens of Eastman Kodak's rare-earth glass for better aberration correction. Has diopter scale. Smooth focusing ⅜" movement. Outside diameter of attaching threads, 3" — 32 threads per inch. Clear aperture of eye lens 2", field lens 1-25/32". Weight 3½ lbs.

Stock #50,091-Y .... **$9.95 ppd.**

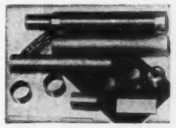
ADAPT GIANT ERFLE TO STANDARD TELESCOPE EYEPIECE SIZE

This adapter lets you use our Giant Erfle with any telescope that has a standard 1¼"-diameter eyepiece holder. Of course, you won't get the full field of the Erfle, but you will get a wider field than with a regular eyepiece. Adapter is made of black anodized aluminum tubing approx. 2¾" long and 3⅜" wide.

Stock #50,358-Y .... **$3.95 ppd.**

Attention! For Beginners, Junior Astronomy Clubs, Boy and Girl Scouts, School Science Clubs

MAKE 8X ASTRONOMICAL SCOPE with Low-Cost Beginner's Kit!



Every boy and girl of today dreams of being a part of the exploration of outer space. That desire makes building his own telescope a real thrill. Now anyone of Cub Scout or Brownie age on up can make his own astronomical 8-power telescope in one evening, without tools or machinery. Here is an ideal, attractive group project for scouts, junior astronomy clubs, or similar groups. (See special quantity prices.) Scope is powerful enough to show craters of the moon, Jupiter's satellites, and many stars not visible to the naked eye. Kit includes objective lens, field lens, eye lens, glare stops, kraftboard tubes, cadmium-plated metal ferrules, and other parts to build an 18"-long, 1¾"-diameter telescope of 8 power.

Stock #70,238-Y .... **$3.00 ppd.**

SPECIAL QUANTITY PRICES

Stock #70,239-Y .... 5 kits .... **$12.50 ppd.**
Stock #70,240-Y .... 10 kits .... **$22.50 ppd.**

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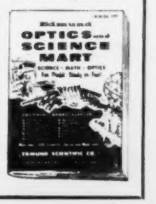

Fantastic variety — rarely before have so many lenses, prisms, optical instruments, and components been offered from one source. Probably the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Many science and math learning and teaching aids.

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BARRINGTON • NEW JERSEY

GLEANINGS FOR ATM's

CONDUCTED BY ROBERT E. COX

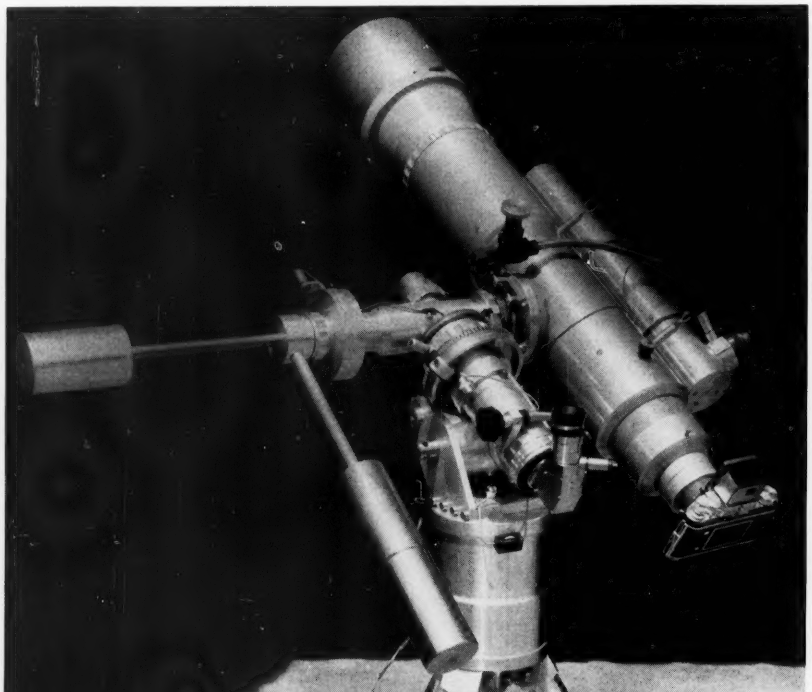
A Precision-Mounted Small Refractor

Some telescope makers build complete instruments including the optics, while others purchase the optics but make all the mechanical parts themselves. A fine instrument with commercial lenses has been made by L. R. Wottring, 974 Mt. Curve Ave., Altadena, Calif., a research and development engineer whose hobby is precision machine work.

A $4\frac{1}{2}$-inch five-element photographic lens of 36" focus forms the main objective. Since it has diaphragm stops of f/8 through f/22, it can be used for astronomical or telephoto-terrestrial photography. In the construction, aluminum was used throughout, except for the studs and bolts, which are stainless steel. The knurled rings on the mounting were especially made to match the one on the main lens of the 35-mm. reflex camera. A special tool had to be built to form these parts, but Mr. Wottring spared no effort to make his instrument uniform in appearance.

The reflex camera, an Exakta VX IIa, is interchangeable with an adapter for large-field and standard $1\frac{1}{4}$"-diameter eyepieces. Provision was also made for using an achromatic Barlow lens and either the camera or eyepiece, the highest power being with the Barlow and a $\frac{1}{2}$-inch eyepiece. Rapid focus is by means of a rack and pinion, while a fine-thread arrangement permits delicate focusing at the eyepiece.

The finder mounted on the main tube has a $2\frac{1}{2}$-inch objective of 16" focus, and with a $\frac{3}{4}$-inch eyepiece gives a good field for locating celestial objects. Its reticle is illuminated by a red light in order to preserve the dark adaptation of the ob-



L. R. Wottring's carefully constructed mounting has an extra counterweight to balance the heavy objective lens, which has five elements.

server's eye. Quick finding and centering are done with the two ring sights seen just to the left of the finder in the picture. These are coated with luminous paint, which is activated with a flashlight at the start of an evening's observation of the sky.

The polar axle is hollow, containing a built-in optical system and reticle for rapidly aligning the mount on the north celestial pole. The crosshairs are also red-lit, and a penta prism is used as a diagonal to bring the image to a convenient viewing position. In this mounting, latitude adjustment from 0° to 50° is possible. There are five-minute divisions on the hour circle, and the index mark is illuminated by red light. The small oblong box just below the polar-adjustment eyepiece contains a rheostat for varying the intensity of the red lights. On the polar-axis housing is a black knurled knob and flexible shaft for slow-motion control; a similar unit for declination can be seen extending over the main tube and finder.

The counterbalancing system is unusual but necessary. Without this addition, weight of the large lens would put the center of gravity awkwardly close to the upper end of the large tube. The arrangement here not only overcomes this condition but contributes to the balance around the polar axis. The declination circle is divided into 1° units and is also illuminated.

A variable-rate unit is incorporated in the clock drive, so it can be easily set to follow stars, planets, or the moon. The speed is controlled by a governor, adjusted by means of a micrometer screw; this unit monitors a secondary circuit to the drive motor. The drive can use power from either a 12-volt automobile battery or 115-volt alternating current, a transformer and diode rectifier being used in series for a.c. operation. The governor and control system for the drive are mounted on a shelf between the tripod legs. This shelf strengthens the assembly, preventing the legs from spreading outward or twisting when the heavy instrument is rotated.

Large aluminum tripod legs that have adjustable points at their ends to allow leveling are used, so that when the mount is aligned on the pole by means of the polar-axis boresight, the clock will track stars accurately. The north leg (left in picture) has a handle for lifting and steering the assembly when the two legs at the south end of the polar axis are placed on a small two-wheeled carriage, thus allowing easy transportation to and from storage. In actual use, the three legs sit in retaining cups permanently set in a concrete driveway.

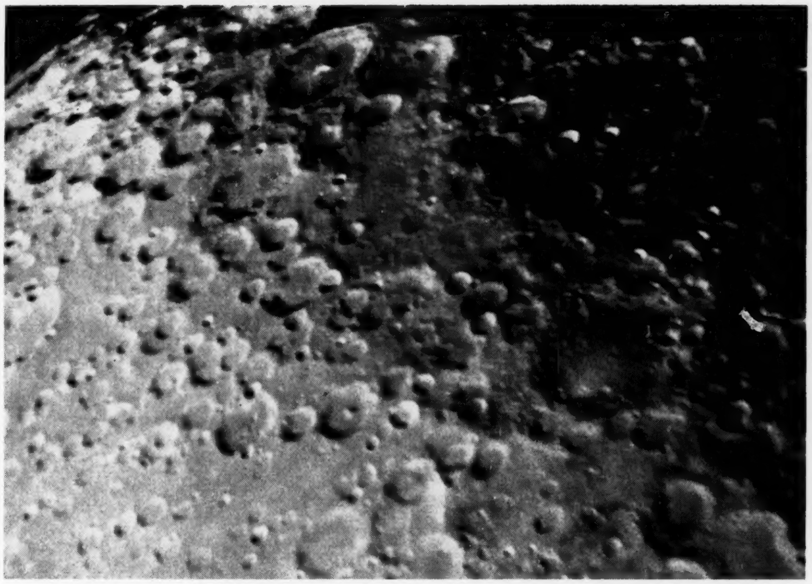
R. E. C.

LIGHTWEIGHT BINOCULARS

Improved astronomical observations at low power may be expected in the future by using lightweight 7 x 50 binoculars that have been designed at the Frankford Arsenal by P. R. Yoder, Jr. He describes them, together with a new 6 x 20 binocular for daytime observing, in the Optical Society of America's *Journal* for May, 1960.

The 7 x 50's are of conventional optical arrangement, with Porro prisms, but they incorporate a three-element air-spaced telephoto objective and an eyepiece of three cemented doublets. The speed of f/3 thus obtained permits using small prisms and still maintaining a seven-degree field of view. The over-all optical path length and the diameter of the objective's flint element are also reduced. The general reduction in instrument size, and the use of magnesium metal wherever possible, results in a total instrument weight of only 25 ounces, whereas conventional 7 x 50's weigh 53 ounces. The new instrument is as small and light as ordinary 6 x 30's.

Mr. Yoder's prototype models are undergoing tests by the U. S. Army, with Navy and Air Force trials expected in the near future. A new approach to binocular maintenance has been adopted in their manufacture. The very small 6 x 20's will not be repaired at all — if defective or damaged they are to be thrown away. The 7 x 50's can be mended in the field by replacing one of five unit assemblies, each being preadjusted at the factory.



W. T. Thomas, Jr., took this $1\frac{1}{2}$-second picture of the moon at 1:25 Universal time, August 14, 1959. The very large crater at upper right is Clavius.

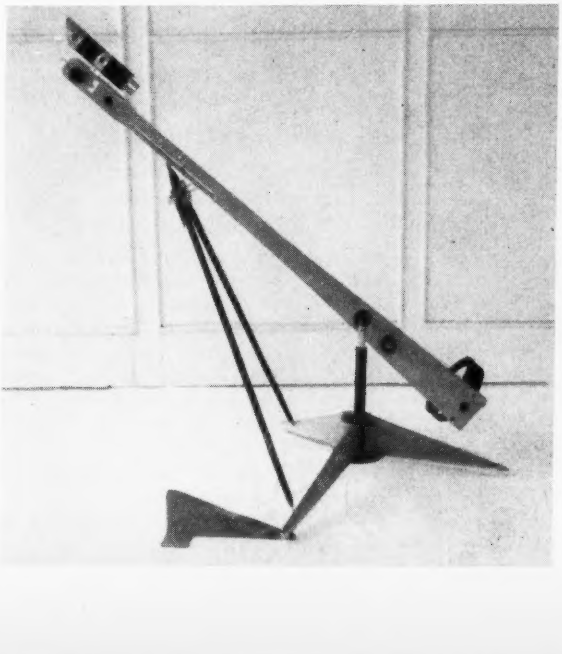
An Altazimuth Reflector with a Drive

THE TYPE of altazimuth reflector pictured below has been popular at our amateur club here in Daytona Beach for a number of years. We like the tubeless or beam construction, and find that the telescope's portability makes it ideal for use at meetings and star parties. And the addition of what I call a *steadier* with a pneumatic slow-motion drive allows good photographs of the moon and planets to be taken, with exposure times ranging up to 10 seconds.

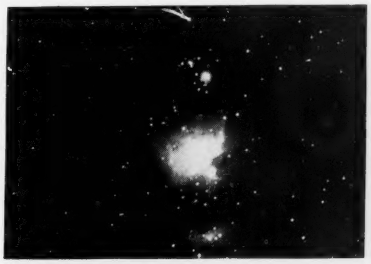
The steadier is triangular in shape and supports the telescope beam near the eye end. The result is that a telescope at 360 power will handle as easily and seem as steady as one of our earlier models at 50 power. Eyepieces can be changed at will, without losing the object under observation. The instrument is very little affected by wind, as the beam does not have the air resistance of a bulky tube, and there can be no internal air currents to affect the seeing.

A telescope with a steadier must first be pointed in the general direction of the object to be viewed. The beam can then be moved nearly two inches either way along the steadier, and up and down a suitable distance until the object is found. For photography, one of the tripod legs is propped upward by means of a wedge-shaped block, so the east-west path of the moon or a planet parallels the direction of the slow-motion movement. It is best, of course, if the field being photographed is within about an hour of the meridian, so the tripod leg is not raised very high.

The first "clock" that I tried was of the



A very low tripod and the vertical adjustable axle in a pipe collar form the mounting of Mr. Thomas' tubeless f/9 6-inch Newtonian reflector. A $1\frac{1}{4}''$ beam of light wood supports the primary mirror and cell at one end and the secondary mirror and eyepiece holder at the other. The "steadier" is made of 5/8" dowels, which are seen extending from the two left-hand tripod legs to the slotted upper part of the beam. The entire instrument weighs only $9\frac{1}{2}$ pounds.



windup type, but this made varying the speed difficult. Now I use an Austin Craft model-airplane ignition timer (originally \$1.25), which has a pneumatic cylinder and plunger, its speed being controlled by an air-bleed screw. This pneumatic clock is rigged to the steadier where the telescope beam rides on it, and the linkage of levers and wires causes the beam to turn slowly around the vertical axis of the mounting – hence the direction of viewing follows an object across the sky for the period during which the pneumatic clock operates.

By this means I have taken photographs of the moon, Jupiter, and Saturn, in the last case obtaining an 8-second exposure that shows one planetary belt and Cassini's division in the rings. Anyone who wishes detailed sketches of the steadier and drive should write to me.

WILLIAM T. THOMAS, JR.
105 N. Halifax Ave.
Daytona Beach, Fla.

SOME RULES OF THUMB

SEVERAL READERS have asked about the conventional relation between mirror and tube size, and diagonal position and size. Here are some rules of thumb that represent the general experience of amateurs over the years. They may not, however, all apply when special observing conditions are to be met.

Tube size: To allow adequate ventilation inside the tube, it is best to have an extra inch all around the mirror, using an 8" tube for a 6-inch reflector, a 10" tube for an 8-inch, and so on. Many 6-inch instruments, however, work well in 7" tubes.

Diagonal position: Two factors are involved here, the size of the diagonal and the diameter of the telescope tube. To allow for the eyepiece holder, the Newtonian focal plane should be at least 2" outside the tube, making it 7" or more from the optical axis of an 8-inch reflector. If such a mirror is f/8, its focal length is 64" and the diagonal would be placed 57" from the mirror. For a 6-inch f/9, in a 7" tube, the diagonal-to-focal-plane distance should be $5\frac{1}{2}$", placing the secondary $48\frac{1}{2}$" from the primary.

Diagonal size: The formula for this is

$$D = v + C(M - v)/F,$$

where D is the diagonal size in inches (minor axis), v is the diameter of the field of view or focal-plane image, C is the distance the flat is placed inside of focus, M is the primary-mirror diameter, and F its focal length. A good rule-of-thumb assumption is that $v = F/100$.

For an 8-inch instrument, f/8, with C made 7", v is 0.64" and the formula gives nearly 1.5" for D, indicating that the diagonal's minor diameter should be $1\frac{1}{2}$". For the 6-inch, f/9 example above, the result is 1.1".

R. E. C.

From Any Point of VIEWING . . .
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CELESTIAL CALENDAR

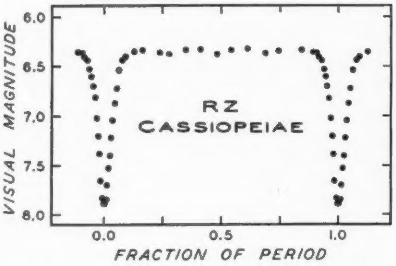
Universal time (UT) is used unless otherwise noted.

The Eclipsing Variable Star RZ Cassiopeiae

MANY years ago, the German astronomer K. Graff wrote: "Of all the bright variable stars of the Algol type, apart from Beta Persei itself, RZ Cassiopeiae is undoubtedly the easiest to observe. Its circumpolar location, its readily identifiable field on a line from Epsilon Cassiopeiae through Iota, its large amplitude and great maximum brightness, its short period — all these give the star a special significance, and I can scarcely name another object better suited for visual brightness estimates with small instruments."

The variability of RZ Cassiopeiae was discovered in 1906 at Potsdam Observatory by G. Müller, and it was soon found to be an eclipsing binary star with a period of 1.195 days. Most of the time it is at maximum brightness, magnitude 6.4. When primary eclipse begins, RZ Cassiopeiae takes only two hours to fade to magnitude 7.8, and two hours more to recover its full light. The general character of the changes is well illustrated by the accompanying light curve, formed from 575 visual estimates made by N. Florja during the years 1923-33. It even indicates the shallow secondary minimum, only 0.05 magnitude deep, which occurs midway between the deep primary eclipses.

A particularly interesting property of RZ Cassiopeiae is the marked variation in the length of its period. During the last decade the period has gradually shortened, and the minima are currently occurring nearly half an hour earlier than the predictions from a formula that was correct



This light curve of RZ Cassiopeiae was compiled by E. Slonim from visual observations by N. Florja. Adapted from the Soviet journal "Variable Stars," Vol. 5 (1937).

in 1953. From visual estimates of brightness, the amateur can determine the time of minimum light to within a few minutes. Hence, such determinations are useful for tracing the unpredictable fluctuations in period.

To observe RZ Cassiopeiae, no more equipment is needed than 7 x 50 binoculars, a finder telescope, or a 2-inch refractor with a low-power eyepiece. Beginning about one or 1½ hours before the scheduled time of minimum, estimate the magnitude of RZ Cassiopeiae in terms of the comparison stars in the accompanying chart. These estimates are to be continued at roughly 10- or 15-minute intervals until one or 1½ hours after midminimum. The time of each observation should be recorded to the nearest minute.

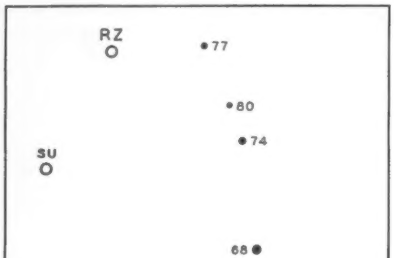
An important precaution in observing RZ Cassiopeiae, or any other rapidly varying star, is to avoid bias. Each estimate should be as nearly independent of those before as is possible, and the observer should not be influenced by the scheduled time of minimum (which in any case is uncertain).

The following predicted times of primary eclipses include only those occurring during hours of darkness for North America. They are expressed in Universal time, in hours and tenths. To obtain predictions of other minima, add to the times given, or subtract, multiples of 1 day 4.69 hours.

October 26, $3^h.1$; 27, 7.8. November 1, 2.5; 2, 7.2; 7, 1.9; 8, 6.6; 13, 1.4; 14, 6.0; 19, 0.8; 20, 5.5; 21, 10.2; 25, 0.2; 26, 4.9; 27, 9.6. December 2, 4.3; 3, 9.1; 8, 3.8; 9, 8.5; 14, 3.2; 15, 7.9; 20, 2.6; 21, 7.3; 26, 2.0; 27, 6.7.

This ephemeris is based on new elements that satisfy the minima observed from 1953 to 1960.

Readers who make observations of RZ Cassiopeiae are invited to send a transcript of their estimates to Sky and Telescope for analysis and evaluation of the times of minimum.



North is toward the top in this finder chart for RZ Cassiopeiae, and one degree is about 1.1 inches. Comparison stars are labeled with their magnitudes to the nearest tenth, the decimal points being omitted. In the same field is the Cepheid SU Cassiopeiae, which varies between magnitudes 5.9 and 6.4 in a period of 1.95 days.

TRANSIT OF MERCURY

Every observer in the Americas should circle Monday, November 7th, on his calendar. On that date Mercury will pass across the face of the sun. In Central and South America, and in the eastern and middle parts of North America, both the beginning and end of the spectacle will be visible. For watchers on the West Coast and in the Northwest, however, the transit will be in progress when the sun rises.

This five-hour event begins at 14:34 Universal time (8:34 a.m., Central standard time) and ends at 19:12 UT (1:12 p.m. CST), these times being valid to within a minute or two throughout the Western Hemisphere. The planet comes onto the sun's disk at position angle 148° (southeast quadrant) and exits at 262° (near the west point of the sun).

Mercury will appear as a round, black, very small dot, its angular diameter of 9.9 seconds of arc being only 1/200 the sun's. Though too small to be detected without optical aid, the planet in transit is readily observable in a 2- or 3-inch telescope. Adequate precautions should be taken to protect the observer's eyes from the blinding glare of the sun. One safe method is to project an enlarged image of the sun through the eyepiece onto a white screen (see page 283).

For detailed observing information, consult the article beginning on page 214 of last month's Sky and Telescope.

VARIABLE STAR MAXIMA

November 9, T Cephei, 210868, 6.0; 11, RU Cygni, 213753, 8.0; 13, V Monocerotis, 061**702**, 7.0; 14, R Reticuli, 043**263**, 7.6; 21, T Eridani, 035**124**, 8.0.

December 11, T Centauri, 133**633**, 5.5.

These predictions of variable star maxima are by the AAVSO. Stars are listed only if brighter than magnitude 8.0 at an average maximum. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for their maxima. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted visual magnitude.

MINIMA OF ALGOL

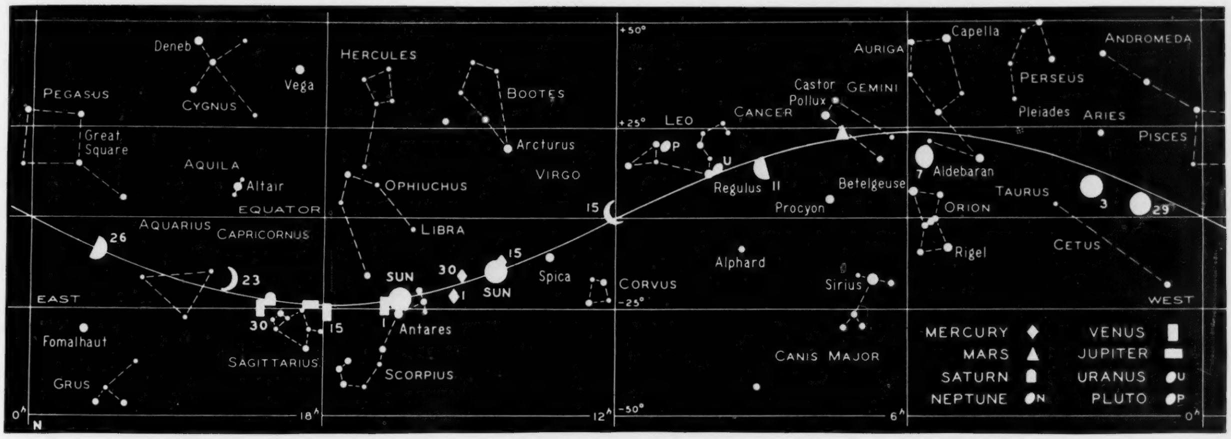
November 1, 17:35; 4, 14:24; 7, 11:12; 10, 8:01; 13, 4:50; 16, 1:39; 18, 22:28; 21, 19:17; 24, 16:06; 27, 12:55; 30, 9:44.

December 3, 6:33; 6, 3:22; 9, 0:11; 11, 21:00; 14, 17:49.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of the star's least brightness.

UNIVERSAL TIME (UT)

TIMES used in Celestial Calendar are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown. For example, 6:15 UT on the 15th of the month corresponds to 1:15 a.m. EST on the 15th, and to 10:15 p.m. PST on the 14th.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0^h Universal time on the respective dates.

Mercury arrives at inferior conjunction with the sun on November 7th, its transit across the solar disk being visible in Europe, Africa, the Americas, and the Pacific Ocean (see facing page). The planet then moves into the morning sky, and reaches greatest western elongation, 20° from the sun, on the 24th. The week preceding and the week following that date are good for observing this −0.3-magnitude object, for Mercury rises about $1\frac{3}{4}$ hours before the sun and may be seen low in the sky to the south of east.

Venus on the 15th is a prominent evening star of magnitude −3.5 in Sagittarius, setting about two hours after the sun. Telescopically, the planet appears as a gibbous disk 79-per-cent illuminated and 14″ in diameter. Venus will overtake first Jupiter and then Saturn on the evenings of the 18th and 27th, respectively. In both cases, Venus passes some two degrees south.

Mars is stationary in right ascension on November 21st and then begins retrograde (westward) motion among the stars. At this time the reddish planet rises about three hours after sunset and is of magnitude −0.6. In a telescope its disk can be seen, 13″.1 in angular diameter.

Jupiter in the middle of the month is low in the southwestern sky for nearly $2\frac{1}{2}$ hours after sunset, in Sagittarius, its magnitude being −1.5. On the 15th the oblate disk has an equatorial diameter of 33″.3 and a polar diameter of 31″.1.

Saturn is approximately 12° east of Jupiter and sets almost $3\frac{1}{4}$ hours after the sun in midmonth. Throughout November its magnitude is +0.8. In a telescope the rings are readily visible, being 35″.3 across on the 15th, while the planet's equatorial diameter is 15″.7. The moon will pass some 4° north of Saturn on the morning of the 22nd.

Uranus is at western quadrature on November 22nd, when it rises about an hour before midnight, local time, and crosses the meridian about $\frac{3}{4}$ hour before sunrise. On the 15th this 6th-magnitude planet is at right ascension $9^h\ 52^m.2$, declination +13° 41′ (1950 co-ordinates), and should be easily located with binoculars $1\frac{1}{2}$° northwest of Nu Leonis (magnitude 5.2).

Neptune is in conjunction with the sun on November 1st, and hence not observable this month.

WILLIAM H. GLENN

MINOR PLANET PREDICTIONS

Psyche, 16, 9.5. November 12, 4:55.1 +17-49; 22, 4:47.1 +17-31. December 2, 4:38.1 +17-14; 12, 4:29.1 +17-00; 22, 4:21.2 +16-52. January 1, 4:15.4 +16-51. Opposition on December 3rd.

Laetitia, 39, 10.1. November 12, 5:37.7 +7-53; 22, 5:31.4 +7-21. December 2, 5:23.2 +7-01; 12, 5:14.0 +6-55; 22, 5:05.1 +7-05. January 1, 4:57.4 +7-29. Opposition on December 11th.

Harmonia, 40, 10.2. November 22, 5:48.8 +21-07. December 2, 5:39.4 +21-21; 12, 5:28.1 +21-35; 22, 5:16.5 +21-49. January 1, 5:06.2 +22-02; 11, 4:58.7 +22-14. Opposition on December 14th.

After the asteroid's name are its number and the approximate visual magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

MOON PHASES AND DISTANCE

Full moon	November 3, 11:58
Last quarter	November 11, 13:48
New moon	November 18, 23:47
First quarter	November 25, 15:42
Full moon	December 3, 4:25

November	Distance	Diameter
Apogee 9, 9^h	251,600 mi.	29′ 31″
Perigee 21, 4^h	225,700 mi.	32′ 54″
December		
Apogee 7, 3^h	252,100 mi.	29′ 27″

NOVEMBER METEORS

Two rather sparse meteor showers occur this month. The full moon will seriously interfere with observations of the Taurid shower maximum on November 5th, but watchers should be able to see some Taurid meteors for a fortnight before and after that date. The Leonid shower reaches maximum on the morning of the 16th, before new moon. At that time a single observer may see some 15 meteors per hour; about half of these are associated with the shower. W. H. G.

JUPITER'S SATELLITES

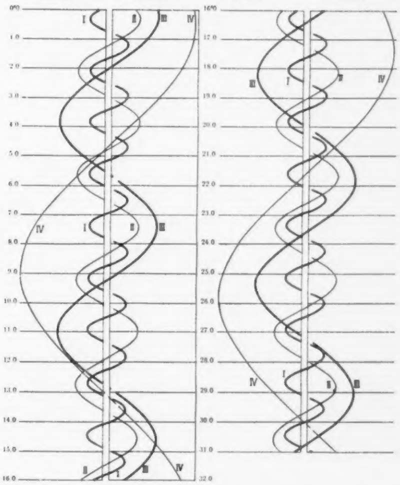
The curves in the accompanying chart show the positions of Jupiter's four bright moons, as seen in an inverting telescope, with north at the bottom and east at the right. Each horizontal line is for 0^h Universal time on the date specified, and the intersections of the line with the curves indicate the places of the satellites at that time. For other Universal times, interpolate between the 0^h lines. The double vertical lines represent the planet's disk.

The lower section is intended to aid observations of the eclipses of Jupiter's moons; *d* is the point of disappearance of the satellite in Jupiter's shadow, *r* is the point of reappearance. The chart is from *The American Ephemeris and Nautical Almanac;* for further explanation, see page 446 of Sky and Telescope for May, 1960.

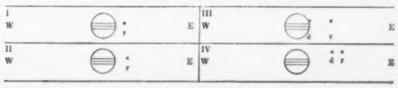
Jupiter's Satellites in November

UNIVERSAL TIME

West *East* *West* *East*



PHASES OF THE ECLIPSES



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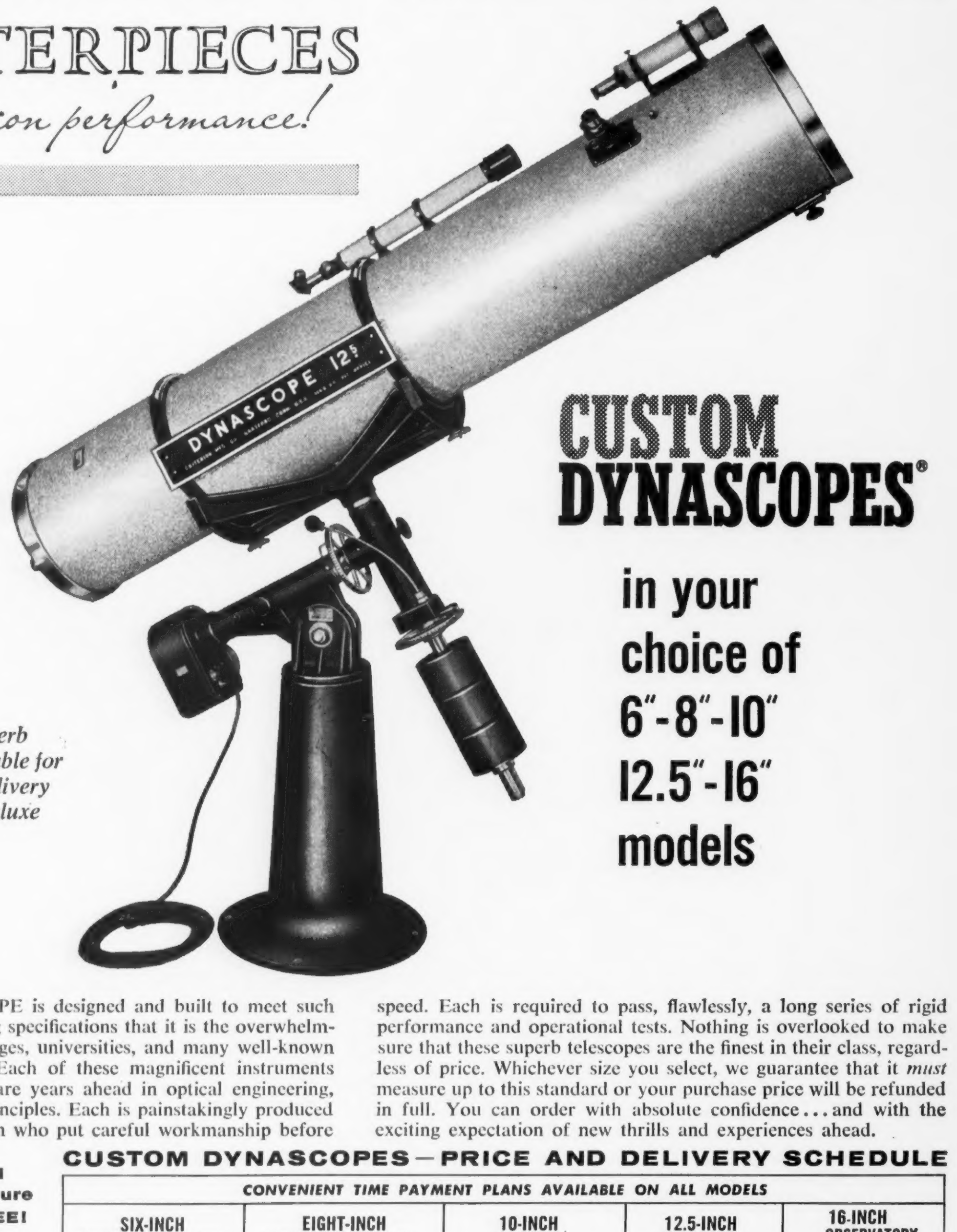

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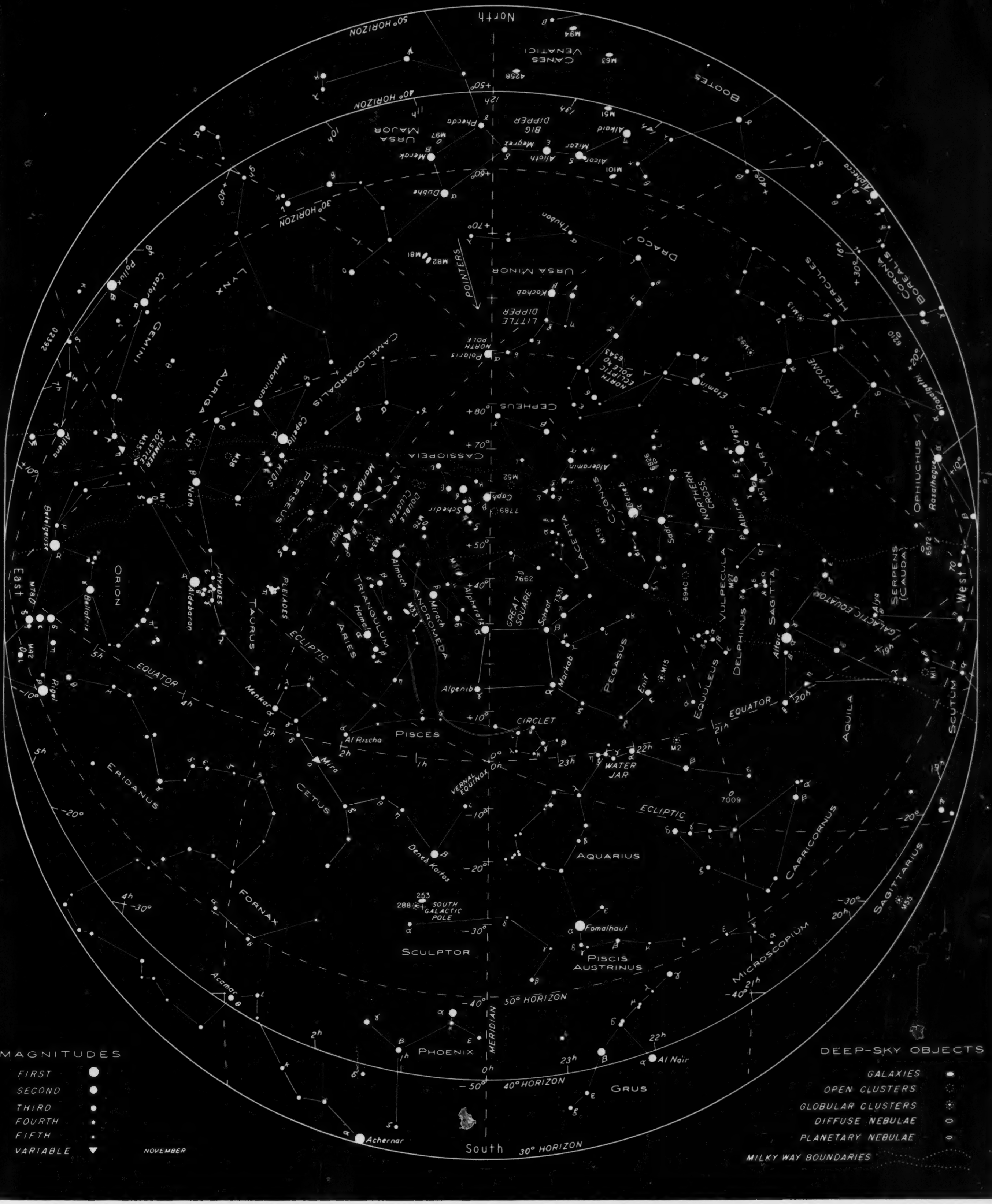
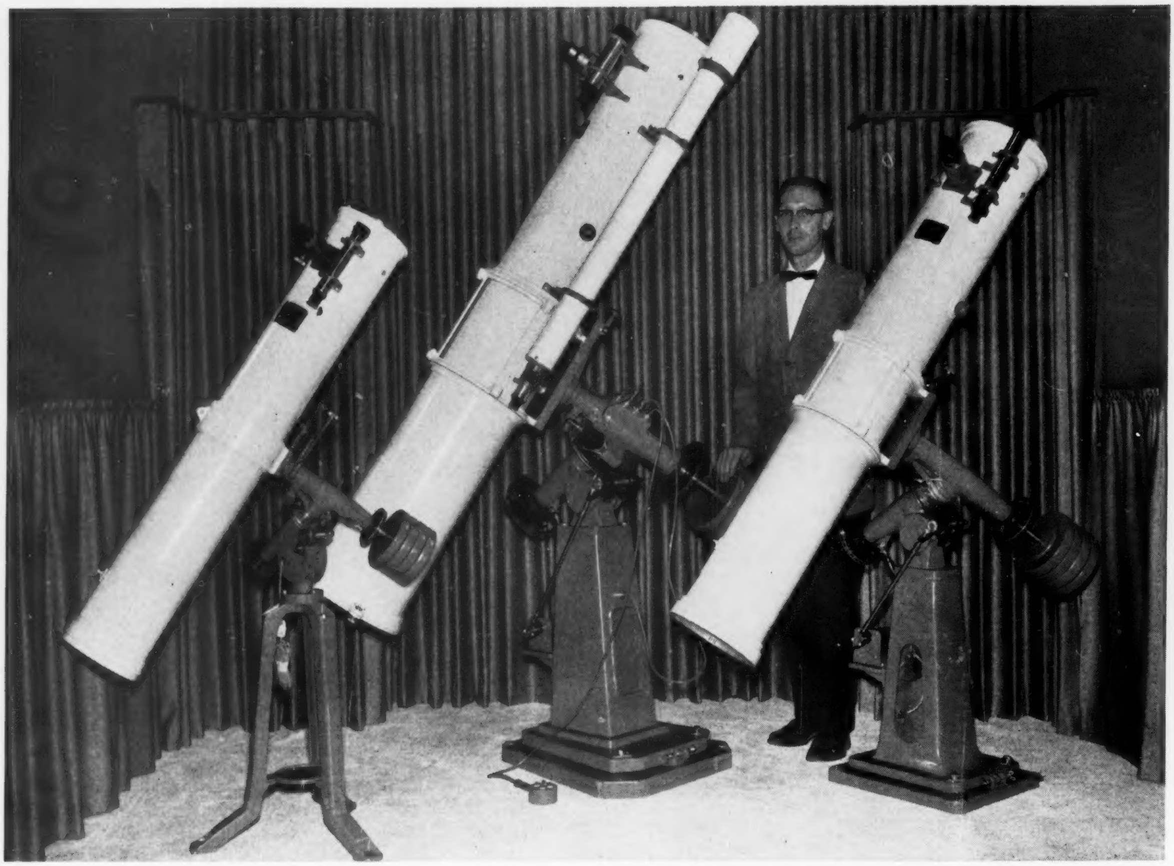


STARS FOR NOVEMBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 6th and 21st of November, respectively; also, at 7 p.m. and 6 p.m. on December 6th and 21st. For other dates, add or subtract ½ hour per week.

Many bright stars now overhead have names that are corruptions of those used by Arab peoples centuries ago. The Great Square of Pegasus is formed by four: Alpheratz (now part of Andromeda), the horse's navel; Scheat, the shoulder; Markab, the saddle; and Algenib, the wing.



NISHIMURA 6-INCH, 10-INCH, and 8-INCH NEWTONIAN REFLECTORS

All Nishimura telescopes described here are manufactured to meet the exacting standards of the professional observatory. Biela Observatories, Inc., presents Nishimura astronomical instruments with the assurance that you will be satisfied with the quality and workmanship. If an instrument does not meet these specifications to your satisfaction, the full purchase price will be refunded.

OPTICAL SPECIFICATIONS

6-inch: focal length, 54 inches; f/9
8-inch: focal length, 64 inches; f/8
10-inch: focal length, 80 inches; f/8

Optical accuracy: 1/8-wave sodium light or better.

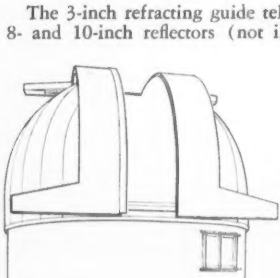
Mirror and diagonal ground on back and edges for precise positioning; both mirrors flotation mounted.

Full complement of eyepieces: 4-mm., 6-mm., 9-mm., 12.5-mm., 18-mm., 25-mm., 40-mm. Give the following magnifications: 6-inch, 33x to 333x; 8-inch, 40x to 400x; 10-inch, 50x to 500x.

Finderscope:

6-inch: 7x achromatic finder, 1.2-inch objective, 5-degree field.
8-inch: 8x achromatic finder, 1.6-inch objective, 5-degree field.
10-inch: 7x achromatic finder, 2-inch objective, 6-degree field.

The 3-inch refracting guide telescope is standard equipment on the 8- and 10-inch reflectors (not illustrated on 8-inch). Focal length, 45 inches, f/15, mounted on main tube, with prism-type star diagonal. Four eyepieces of your choice.



All eyepieces, including one universal solar filter, furnished in a neat wooden case for convenience and protection. The eyepieces fit both the reflector and auxiliary refractors.

ENGINEERING SPECIFICATIONS

Heavy cast-aluminum tripod for the 6-inch reflector; massive cast-iron pier for 8- and 10-inch, with adjustable double pier plate for precise polar alignment.

Cast-iron German-type equatorial mounting, adjustable polar axis with graduated latitude indicator.

Brass setting circles with vernier reading (no vernier on the 6-inch reflector), accurately engraved for right ascension and declination.

110-volt, 60-cycle, sidereal-rate electric clock drive with heavy-duty motor.

Manual slow-motion controls on 6- and 8-inch reflectors; electric slow-motion controls on the 10-inch. These controls operate in right ascension and declination independently of the sidereal-rate electric clock drive.

Positive clamps on both right ascension and declination axes.

Steel tube with machined cast-iron end rings, precision-machined rotation saddle.

Precision rack-and-pinion eyepiece holder with three sizes of adapter rings.

Four independent counterweights on threaded shaft for accurate balancing.

All castings and tubes are finished in high-quality enamel. Castings steel grey, tubes off-white.

All hardware chrome plated.

Metal covers provided for all optical surfaces as added protection.

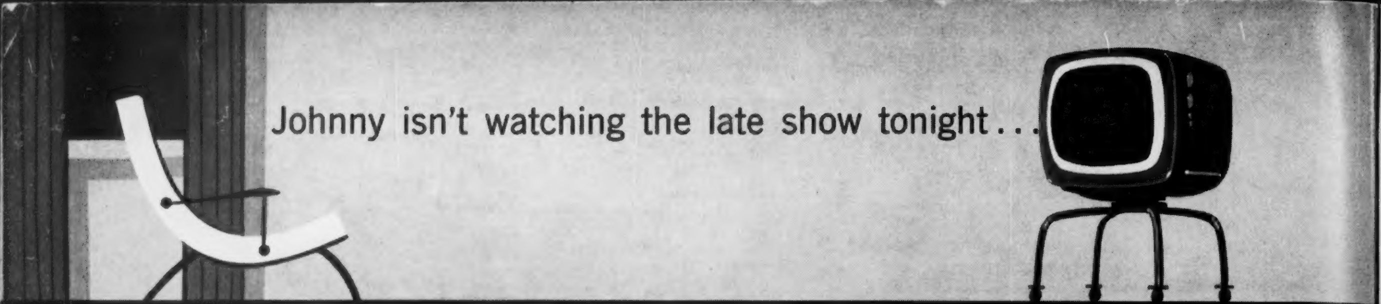
Total net weight: 6-inch, 90 lbs.; 8-inch, 284 lbs.; 10-inch, 490 lbs.

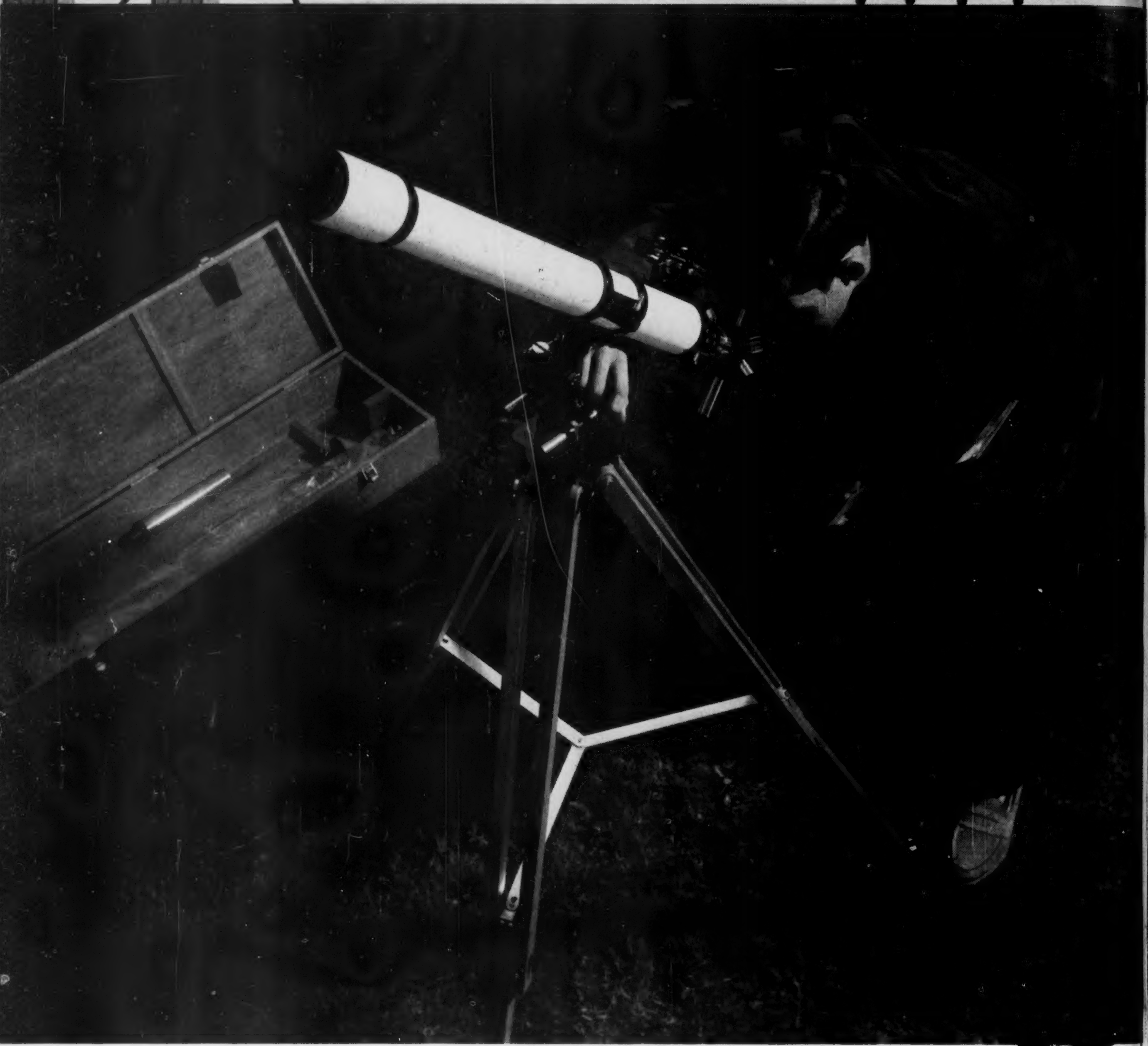
Prices, f.o.b. Anaheim, Calif.: 6-inch reflector, $495.00
8-inch reflector, $995.00
10-inch reflector, $1,495.00

Biela Observatories, Inc.

325 BERRY AVENUE, ANAHEIM, CALIFORNIA. PHONE: KEystone 3-2207

DISTRIBUTOR FOR NISHIMURA ASTRONOMICAL INSTRUMENTS





The shadows that shiver and shake on the TV screen are shivering and shaking in somebody else's living room tonight. Johnny has discovered something new.

He's traded the fleeting, flickering "thrills" of the 24 inch screen for the timeless excitement and majesty of the night sky.

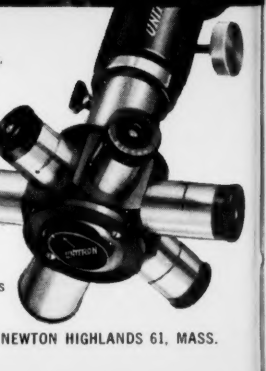
He's traded the nervous rattle of the private eye's gun for a ringside seat at the stupendous nightly fireworks in the heavens.

He has, in short, discovered astronomy.

Nothing better could happen than what happened to Johnny. And it happened simply because someone took the trouble to awaken, nourish and satisfy a lifetime of curiosity in Johnny by making him the gift of a fine telescope.

Someone, not so long ago, gave Johnny a Unitron.

Johnny abandoned his 24" screen for this 2.4" Unitron refractor, complete with its handy, handsome, easily portable carrying case.



This is a close-up of the Unihex Johnny is using. It's 6 eyepieces in one, an exclusive with Unitron. One of a complete line of accessories to multiply your viewing pleasure.

UNITRON INSTRUMENT COMPANY • TELESCOPE SALES DIV. — 66 NEEDHAM ST., NEWTON HIGHLANDS 61, MASS.

SEE PAGES 308 AND 309 FOR MORE ABOUT UNITRON.